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ABSTRACT

Designed for secondary and postsecondary auto mechanics programs, this curriculum guide contains learning exercises in seven areas: (1) brake fundamentals: (2) brake lines, fluid, and hoses: (3) drum brakes; (4) disc brake system and service: (5) master cylinder, power boost, and control valves; (6) parking brakes; and (7) trouble shooting. Each exercise follows a typical format that includes the following sections: objective, explanation, materials needed, tools needed, introduction, information sheets, worksheets, and test. (A description of the project which produced the guide is provided at the beginning of the document.) (LRA)

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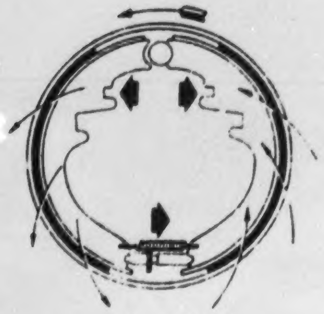
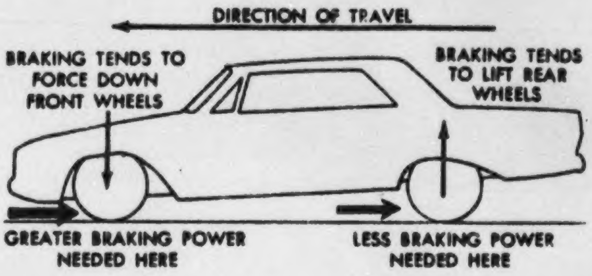
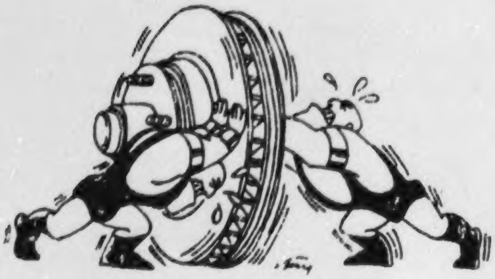
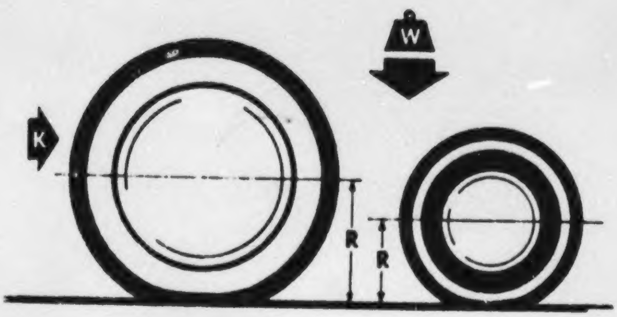
BRAKE

FUNDAMENTALS




DIRECTION OF TRAVEL
BRAKING TENDS TO FORCE DOWN FRONT WHEELS
BRAKING TENDS TO LIFT REAR WHEELS
GREATER BRAKING POWER NEEDED HERE
LESS BRAKING POWER NEEDED HERE





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FINAL REPORT

PROJECT NUMBER 01-012-150-319

SECONDARY-POSTSECONDARY CURRICULUM DEVELOPMENT IN AUTOMOTIVE MECHANICS

Ronald Hoepner
Associate Supervisor, Trades and Industry

VTAE District One
620 West Clairemont Avenue
Eau Claire, WI 54701

in cooperation with

THE WISCONSIN BOARD OF VOCATIONAL, TECHNICAL AND ADULT EDUCATION
DIVISION OF COMMUNITY AND MANPOWER EDUCATION
BUREAU OF PROGRAM DEVELOPMENT

October 10, 1979

The activities reported herein were performed pursuant to a grant with the Wisconsin Board of Vocational, Technical and Adult Education, partially reimbursed from an allocation of federal funds from the U.S. Office of Education, Department of Health, Education and Welfare, under the authority of the Adult Education Act, P.L. 92-230, Section 309, as amended by P.L. 93-380. Points of view or opinions stated do not necessarily represent official State Board or U.S. Office of Education position or policy.

The purpose of this project, as outlined in the initial proposal, was to continue the development of a competency-based curriculum in the automotive mechanics area. This curriculum was to be used by instructors in the CAPSTONE courses at the high school level as well as in the automotive mechanics program at District One Technical Institute. The proposal asserted that the achievement of this objective would enable all students coming into the automotive program at District One to have an equal opportunity to realize their occupational goal. Such opportunity would exist whether the student has had the CAPSTONE course or no opportunity whatsoever to receive previous training in this area.

In aiming at this objective, the project did accomplish the following:

1. Three 3-hour meetings were held during the course of the 1978-79 academic year prior to the summer workshop. Each of these meetings included the six CAPSTONE teachers, five automotive instructors at District One Technical Institute together with the project supervisor (see sample instructional package for names and locations of CAPSTONE teachers and names of District One instructors). During the course of these preliminary meetings, the accomplishments of the first year were reviewed. The competency rating charts for all eight major units were reviewed and a uniform competency certificate was conceived (see sample attached). The second unit to be developed (brakes) was identified. Note that this represents a change from the previously identified sequence. In addition, the procedures to be followed in that summer workshop were established.

2. A three-week workshop was conducted at the Technical Institute in which the participants worked for a period of 35 hours each week (June 11 through 29, 1979).
3. The completion of this workshop saw the continuation of the realization of the development of competency-based curriculum in automotive mechanics which is usable at both the secondary and postsecondary levels (see attached learning package). As indicated in number one above, brakes was identified as the second of eight units to be so developed. These eight units coincide with the eight areas covered on the national certification examination. The brake unit probably constitutes the most important (especially for secondary students) of the remaining seven units. Prior to the development of the remaining six units, District One plans to do some restructuring of its present curriculum.
4. The instructional package in brakes will be piloted by the participating CAPSTONE teachers at the secondary level throughout the 1979-80 school year.
5. The CAPSTONE teachers and District One Technical Institute automotive instructional staff will be in contact during the 1979-80 school year. Input will be obtained through these contacts on the effectiveness of the instructional package which was developed through this project.
6. Use was made of the appropriate V-TECS study, particularly during the meetings preceding the workshop and during the initial phase of the workshop.

7. The final financial report was forwarded to the State Board office on August 16, 1979.

AUTOMOTIVE ARTICULATION PROJECT

Federal Number 01-012-150-319

Project Supervisor: Ronald Hoepner, District 1 Technial Institute

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NOTE: This project was designed to improve communication and coordination between the area high schools and District 1 Technical Institute. It is designed for compatibility in the learning skills taught at both levels. It is meant to serve as a guide and follow-up between the high school and vocational school to insure uniform education with minimum duplication for the Automotive student. A limited number of copies are available at the cost of printing by contacting the supervisor of the project.

This project is not intended for profit.

This material was developed pursuant to a grant or contract with the Wisconsin Board of Vocation, Technical and Adult Education, partially reimbursed from an allocation of Federal funds from the U. S. Office of Education, U. S. Department of Health, Education and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgement in the conduct of the project. Points of view or opinions stated do not therefore, necessarily represent official State Board of U. S. Office of Education position or policy.

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A - BRAKE FUNDAMENTALS
B - BRAKE LINES, FLUID AND HOSES
C - DRUM BRAKES
D - DISC BRAKE SYSTEM AND SERVICE
E - MASTER CYLINDER, POWER BOOST AND CONTROL VALVES
F - PARKING BRAKES
G - TROUBLE SHOOTING

7/0.

Brake Tasks

A. Inspect Drum/Disc Brake System
    1. Check operation of brake pedal
    2. Inspect drums and/or rotor
    3. Inspect linings and/or pads
    4. Inspect brake hardware
        A. Springs
        B. Holddowns
        C. Adjusters
        D. Backing plate
        E. Anchors
        F. Parking brake components and adjust
    5. Inspect hydraulic system
        A. Wheel cylinders/calipers
        B. Master cylinder
        C. Lines/hoses
        D. Control valves
    6. Inspect wheel bearings and seals
    7. Inspect brake pedal rod, mounting, linkage, and free travel
    8. Inspect operation of brake booster
    9. Inspect operation of stoplight and brake warning light

B. Remove and Replace Brake System Components
    1. R/R brake shoes/pads and brake hardware and adjust brakes
    2. R/R hoses and lines
        A. Form and route steel lines
        B. Install hoses
    3. Cut and double flare steel tubing
    4. R/R master cylinder
    5. R/R brake vacuum booster
    6. R/R disc brakes caliper
    7. R/R drum brakes wheel cylinder
    8. R/R bleeder screw
    9. R/R rear axle bearing and seal
    10. Bleed air from drum brake system
        A. Manual bleed
        B. Pressure bleeder
    11. Bleed air from disc brake system
        A. Manual bleed
        B. Pressure bleeder
    12. Flush system with brake fluid
    13. Check and adjust pushrod
    14. R/R free up parking brake components and adjust
    15. R/R, repack and adjust wheel bearings
        A. Disc brakes
        B. Drum brakes
    16. R/R hyd. control valves
    17. R/R hyd. power units
    18. Torque wheel lug nuts

C. Rebuild and Machine Brake Components
    1. Machine brake drum
        A. Turn brake drum
        B. Grind brake drum

2. Machine rotor
    A. Turn rotor
    B. Grind rotor
3. Rebuild caliper assembly
4. Remove and replace riveted lining
5. Arc lining to drum with toe and heel clearance
6. Rebuild wheel cylinder
7. Rebuild master cylinder
8. Rebuild power brake unit
9. Rebuild backing plate

D. Diagnose Drum/Disc Brake System
1. Diagnose brake noises
2. Diagnose abnormal pedal position and action
3. Diagnose dragging brakes, including parking brake drag
4. Diagnose brake fade, erratic brakes, pull, dive, and grab
5. Diagnose tire and suspension related problems
6. Diagnose hydraulic system--valuves, controls, and leaks
7. Diagnose brake warning system
8. Diagnose power brake unit
    A. Vacuum system type
    B. Hydraulic pressure system type
9. Perform road test for performance of brake system
10. Perform dynamometer test for performance of brake system
11. Diagnose anti-skid systems
12. Recenter pressure differential switch

REFERENCE

The texts chosen were selected because they are in current use by the instructors who compiled this manual. You should have a copy of at least one in your shop.

The text books are to be used as references for each exercise in this book. For each exercise you will find a number followed by page numbers. Look up the book number on this list and the page numbers will correspond to the exercise on which you are working. For example, if you find #4. 103-111 in the reference section, you would check this reference list and find that book No. 4 is Auto Mechanics by H. E. Ellinger. In that book, pages 103-111 will apply to the exercise you are working.

	TEXT	AUTHOR	PUBLISHER
1.	Auto Service and Repair 1975	Stockel	Goodheart - Willcox
2.	Auto Mechanics Fundamentals 1974	Stockel	Goodheart - Willcox
3.	Automotive Encyclopedia 1975	Toboldt - Johnson	Goodheart - Willcox
4.	Auto Mechanics 1977 Second Edition	Ellinger	Prentice - Hall
5.	Automotive Mechanics 1970 Sixth Edition	Crouse	McGraw - Hill
6.	The Auto Book 1974	Crouse	McGraw - Hill

Auto Mechanic's
Brake Fundamentals
No. A- Index

A-1 Hydraulics

A-2 Theory and Construction

A-3 Inspection

Auto Mechanics

Brake Fundamentals

No. A-1 Hydraulics

OBJECTIVE: After completion of this exercise, the student will have an understanding of brake system fundamentals.

EXPLANATION: Pass written test with _____% accuracy.

MATERIALS NEEDED: Safety glasses Information sheet # A-1 suggested references.

TOOLS NEEDED:

References	Do
#1.	#1. Read assigned reference material.
#2.	#2. Study information sheet.
#3.	#3. Take written test.
#4.	#4. Have instructor check written test.
#5.	
#6.	
#7.	
#8.	

A-1 - Introduction

This unit covers theory of hydraulics which is the principle means of brake application. Components, types of systems and theory of braking systems are also covered in this unit.

A thorough understanding of brake fundamentals is very important for proper brake system servicing.

DO NOT FILM

Brakes - Fundamentals

No. A-1 Hydraulics

Information Sheet # 1

HYDRAULICS

Meaning of Hydraulics In its simplest sense, hydraulics has to do with certain characteristics of liquids, such as water and oil. Our special interest, so far as the automotive chassis is concerned, is related to the effects of pressure applied to a liquid. This is called hydraulic pressure. Hydraulic pressure is used in the brake system, in shock absorbers, and in power-steering systems. It is also used in automatic transmissions (control circuits, fluid coupling, and torque converter), in engines (hydraulic valve lifters,oil pump, fuel pump,, water pump,) and so on.

Incompressibility of Liquids We have seen that increasing the pressure on a gas will compress the gas into a smaller volume (Fig. A-1). However, increasing the pressure on a liquid will not reduce its volume; its volume stays the same even though the pressure on it is greatly increased (Fig. A-2). A liquid connot be compressed into a smaller volume; it is incompressible. This might be explained as follows. The molecules of the liquid are rather close together--as opposed to a gas, in which the molecules are relatively far apart. Putting pressure on a gas can "squeeze out" some of the space between the molecules. But in a liquid, there is no extra space that can be "squeezed out" by the application of pressure. The molecules are already as close together as we can get them; putting pressure on the molecules of a liquid will not force them closer together.

Transmission of Motion by Liquid. Since liquid is not compressible, it can transmit motion. For example, Fig. A-3 shows two pistons in a cylinder, with a liquid separating them. When the applying piston is pushed into the cylinder 8 inches (203.2 mm) as shown, the output piston will be pushed along in the cylinder for the same distance, or 8 inches (203.2 mm). In this illustration you could subsitute a solid connecting rod between piston A and piston B and get exactly the same effect.

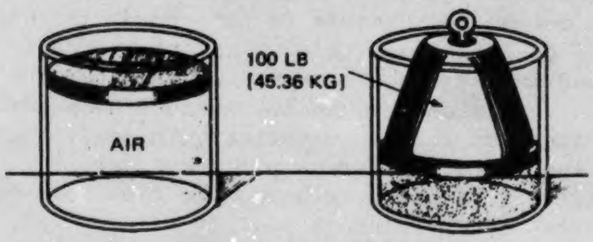
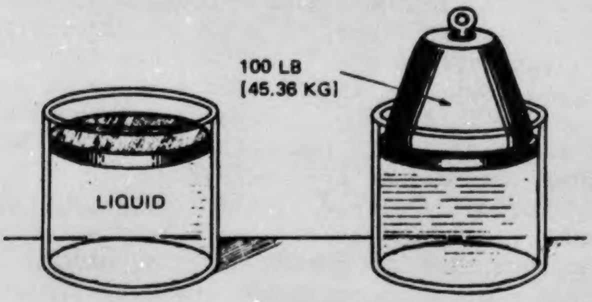

100 LB
[45.36 KG]
AIR

Fig. A-1 GAS CAN BE COMPRESSED


100 LB
[45.36 KG]
LIQUID

LIQUID CANNOT BE COMPRESSED

Fig.A-2 Gas can be compressed when pressure is applied. However, liquid cannot be compressed when pressure is applied. (*Pontiac Motor Division of General Motors Corporation*)

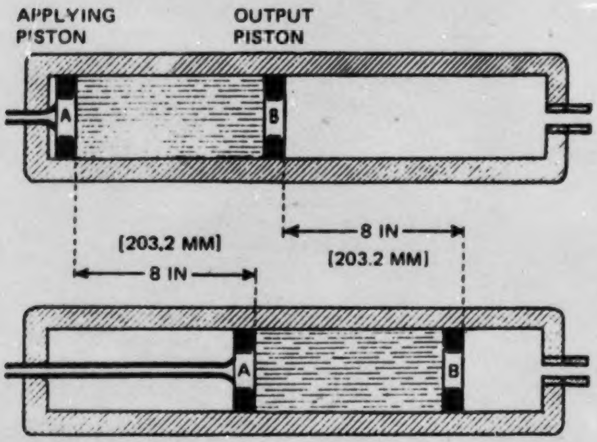

APPLYING
PISTON
OUTPUT
PISTON
A
B
[203.2 MM]
8 IN
8 IN
[203.2 MM]
A
B

Fig.A-3 Motion can be transmitted by liquid. When the applying piston is moved 8 inches [203.2 mm] in the cylinder, the output piston is also moved 8 inches [203.2 mm]. (*Pontiac Motor Division of General Motors Corporation*)

The motion can also be transmitted from one cylinder to another by a tube, or pipe (Fig. A-4). Here, the applying piston is in cylinder A, and the output piston is in cylinder B. As the applying piston is moved into its cylinder, liquid is forced from cylinder A into cylinder B. This causes the output piston to be moved in its cylinder. If both pistons are of the same size, the output piston will move the same distance as the applying piston.

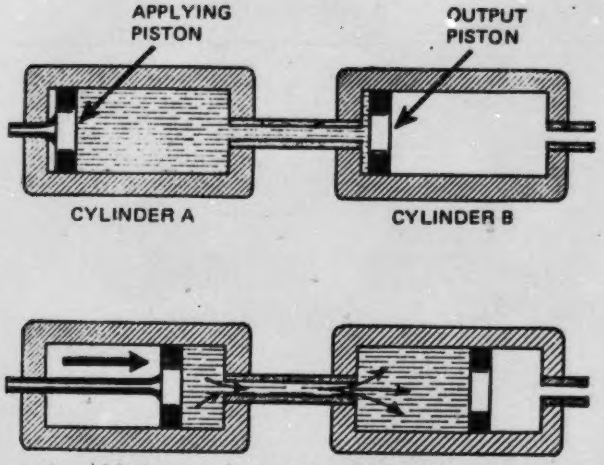


Fig. A-4 Motion can be transmitted through a tube from one cylinder to another by liquid, or hydraulic, pressure. (*Pontiac Motor Division of General Motors Corporation*)

Transmission of Pressure by Liquid The pressure that is applied to a liquid is transmitted by the liquid in all directions and to every part of the liquid. For example, in Fig. A-5 a piston with an area of 1 square inch is shown applying a force of 100 pounds. This is a force of 100 psi. If we attached pressure gauges to various parts of the system, as shown, to measure the pressure on the liquid, we would find the pressure on the liquid the same at all points. Note that regardless of the point where the pressure measurement is taken, we get the same reading.

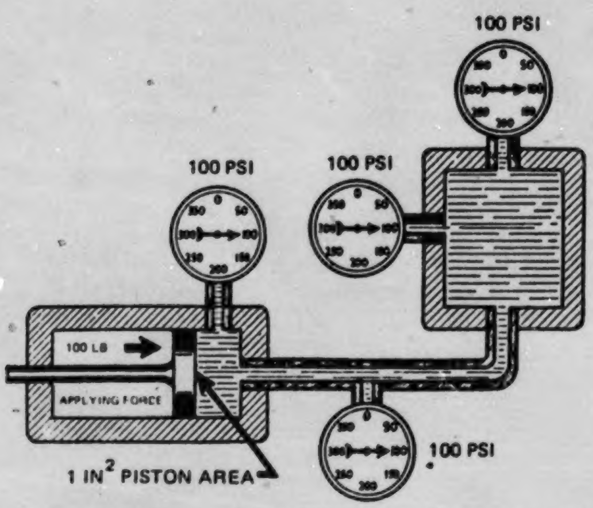


Fig. A-5 The pressure applied to a liquid is transmitted equally in all directions. *(Pontiac Motor Division of General Motors Corporation)*

The pressure is usually referred to in terms of pounds per square inch (psi) or kilograms per square centimeter (kg/cm^2) in the metric system. Thus, when a piston is applying pressure to a liquid, we can calculate the pressure in pounds per square inch if we know the force being applied by the piston and the area of the piston in square inches. For instance, in Fig. A-6 when a 1 square inch piston applies a force of 100 pounds, the pressure on the liquid is 100 psi. But if the area of the piston is 2 square inches and the piston is applying a force of 100 pounds, the pressure on the liquid is only 50 psi. That is, each square inch of the piston is applying only 50 pounds. So the psi is determined by dividing the applied force by the area of the piston in square inches.

When we have an input-output system (Fig. A-7), we can determine the force applied to any output piston by multiplying the pressure in psi by the area of the output piston in square inches. For example, the pressure shown in Fig. A-7 is 100 psi. The output piston at the left has an area of 0.5 square inch. Thus, the output force on this piston is 100 x 0.5, or 50 pounds. The center output piston has an area of 1 square inch, and its output force is therefore 100 pounds. The right-hand output piston has an area of 2 square inches, and its output force is therefore 200 pounds (100 x 2). If the area of the output piston were 500 square inches, the output force, with 100psi applied, would be 50,000 pounds. You can see that hydraulic pressure can be used to apply tremendous loads by making the output piston much larger than the input piston. In big presses used in manufacturing automotive and airplane parts, pressures of hundreds of thousands of pounds are produced by this means.

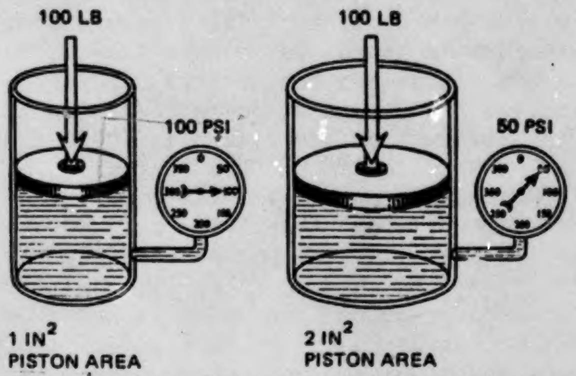

100 LB
100 PSI
1 IN^2 PISTON AREA
100 LB
50 PSI
2 IN^2 PISTON AREA

Fig. A-6 Pressure in the system is determined by dividing the applying force by the area of the applying piston. (*Pontiac Motor Division of General Motors Corporation*)

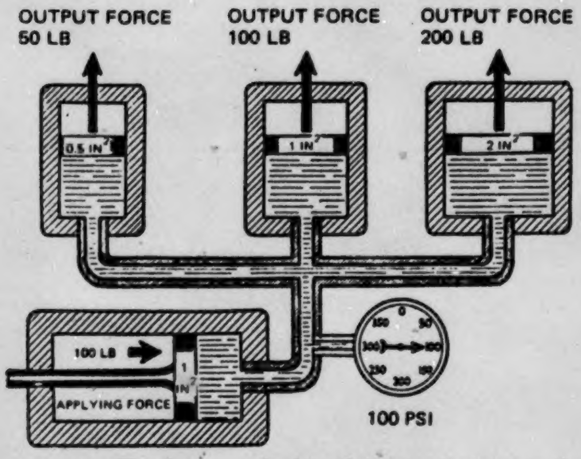

OUTPUT FORCE 50 LB
OUTPUT FORCE 100 LB
OUTPUT FORCE 200 LB
0.5 IN^2
1 IN^2
2 IN^2
100 LB
APPLYING FORCE
1 IN^2
100 PSI

Fig. A-7 The force applied to the output piston is the pressure in the system (in pounds per square inch [kg/cm^2]) times the area of the output piston. (*Pontiac Motor Division of General Motors Corporation*)

INTRODUCTION

The most important safety system of an automobile is its brake system. Safe, sure stopping ability is the key to avoiding auto accidents. In order to maintain and repair a brake system properly, a clear understanding of the brake system is essential for anybody involved in auto service. The basic principle in all braking systems is mostly the same. Stationary shoes press against a rotating surface, generating friction to stop the car (Fig. A-8). Part of the function of the braking system is to dissipate the heat generated due to this friction.

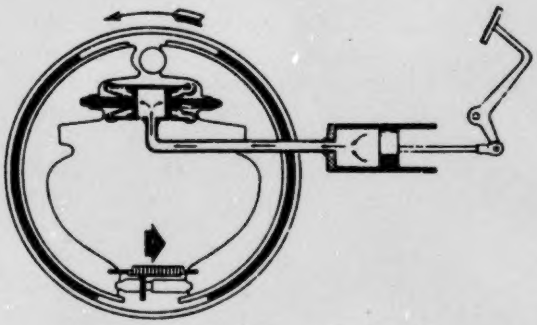


Fig. A-8 —Braking Principle

FRICTION PRINCIPLE IN BRAKING

Friction is nature's way of retarding movement. Force and the coefficient of friction are the two factors that govern all frictional relationships. Force applied to two frictional surfaces causes them to grip and thus resists the movement between them. The coefficient of friction results from the nature or the quality of the material making up the frictional surfaces. It is ratio of the force required to slide an object over a surface to the weight of the object. It is always less than one. A coefficient of friction of 1.00 is undesirable since it would match the "irresistible force against the immoveable object," thus resulting in destruction. If the brakes work at excessively high coeffecient of friction, abrasion would quickly wear down brake linings and drums or discs. Due to this limiting factor automotive brake linings are generally manufactured in low, medium, medium-high, and high friction categories to cover the following practical ranges:

Low friction.	0.25 to 0.30
Medium friction	0.30 to 0.35
Meduim-high friction	0.35 to 0.40
High friction	0.40 to 0.45

Heat generated due to the friction must be absorbed by the drums or discs and then dissipated into the atmosphere. Drums or discs become very hot as they must store the heat until it can be dissipated. Since friction and heat produce wear at the contact surfaces of the brake, good contact is important at the rubbing surfaces in order to distribute pressures and consequently heat over the largest possible area.

BRAKING ABILITY OF A VEHICLE

Vehicle Weight

When the brakes are applied, the weight of the vehicle is one of the factors that determine the stopping ability. If the weight is doubled, the energy of motion which must be converted into heat energy is also doubled. Brakes designed to control a vehicle with a gross weight of 4,500 lbs. (2040 kg), for example, cannot properly absorb and dissipate the amount of heat produced if the same vehicle is so loaded to have a gross weight of 9,000 lbs (4080 kg).

Vehicle Speed

When the brakes are applied, the vehicle speed decreases as the energy of motion is converted into heat energy and the vehicle finally stops. The effect of higher speed is even more serious than the greater weight. When the speed of a vehicle is doubled, four times as much energy of motion is produced. Consequently, when the speed is doubled, the brakes must absorb and dissipate four times as much heat. At the same time, if the weight is also doubled, the brakes must absorb and dissipate eight times as much heat.

Tires and Road

The contact between the vehicle tires and the road is in the form of a rolling friction and it is this friction which must actually stop the vehicle. Should the brakes overcome rolling friction to lock any wheel on the vehicle, the heat must be produced by the small skid area of the tire. Tire diameter is also a factor since leverage between the brake and the wheel is reduced by increases in the rolling radius. The retarding effect offered by the road is called the "K" factor, and determines the maximum amount of deceleration. More simply, the "K" factor tells that a given road surface (asphalt, concrete, gravel etc.) can only tolerate a combination of retarding forces up to "K" percent of the weight being stopped (Fig. A-9). A 0.60 "K" stop, i.e. 60 lb. (27 kg) retarding force per 100 lb. (45 kg) of weight, is the approximate limit of present highways (dry concrete). The "K" factor is less on asphalt still less on gravel, and quite low on slippery ice.

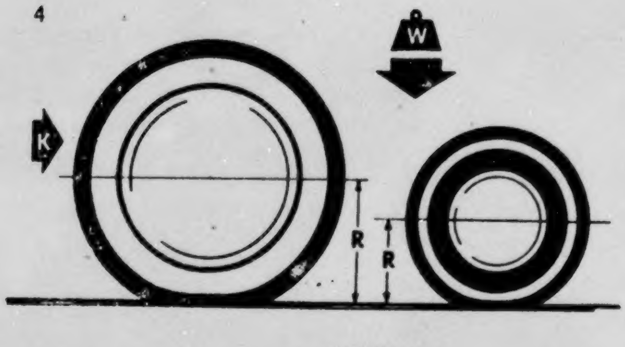


Fig. A-9 —"K" Factor

Overall Braking Ability

The stopping ability of a vehicle of a given weight, at various speeds, depends upon several factors including --

a) Amount of brake lining surface area
b) Radius of brake drum or disc
c) Rolling radius of the wheel and tire
d) Brake lining coeffiecient of friction which can vary with wear, effects of moisture, dirt and heat
e) Coeficient of friction between the tire and the road surface, which can vary with the surface and weather conditions
f) Proper adjustments assuring good rubbing contact
g) Controlling force applying the lining against drums or discs
h) Brake shoe arrangement: In hydraulic brakes, shoes are forced against their drums or discs by pistons under fluid pressure, and to assist or supplement manual operation, the system may include a vacuum or hydraulic boosted power unit. The hydraulic system is now used on all vehicles except heavy trucks and trailers which are equipped with straight-air brake actuating systems utilizing cam operated or wedge operated brake shoes.

DRUM BRAKES

Basic Operation

When a brake pedal is depressed, hydraulic pressure is generated which causes the brake shoes to push outward against a rotating drum (Fig. A-10). Due to the rotation of the drum, the primary (front) shoe tends to activate the secondary (rear) shoe which performs more of the braking at that wheel. Linings on the primary shoes are, therefore, usually shorter than those on the secondary shoes.

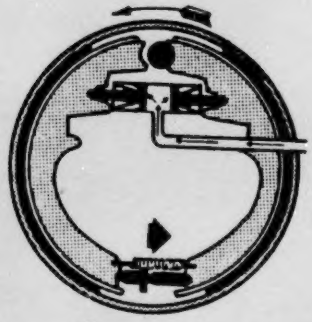


Fig. A-10 —Basic Drum Brake Operation
Forward Braking Motion

Shoe Energization and Leverage Factors

When brake shoes are spread in contact with the rotating drum, the sliding friction drag tends to rotate each shoe about the hinge point (brake anchor). When this friction helps to press the shoe lining into tighter contact with the drum, it acts as a "self-energizing" force which supplements the actuating force to assist the braking operation. Conversely, if the drag tends to force the shoe away from the drum, it resists the actuating force and is called a "de-energizing" force (Fig. A-11).

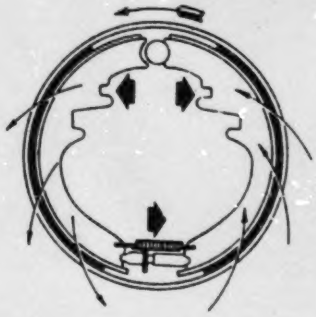


Fig. A-11 —Shoe Energization

Actuating force is applied to one end (toe) of the shoe and the shoe anchor at the opposite end (heel) becomes a fulcrum about which the shoe rotates. This makes the shoe a lever and this leverage assists the actuating and self-energizing forces to press the shoe against the drum. Obviously a larger drum diameter permits more shoe leverage (Fig. A-12).

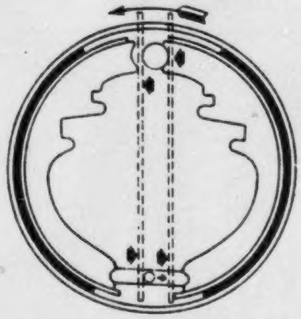
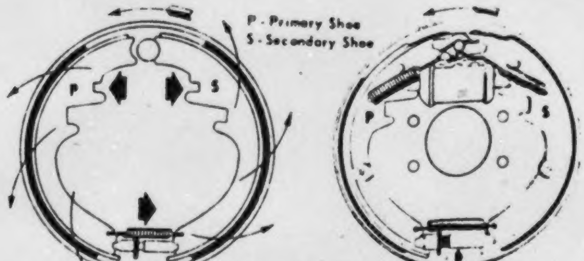


Fig. A-12 —Shoe Leverage

Servo Type Brakes

In these brakes the shoes are so assembled that they form a compound, "primary" and "secondary," shoe unit joined at one end by an adjustable floating link, The drag of a normal (forward) drum rotation causes the primary shoe to leave its anchor and holds the secondary shoe anchored, (Fig. A-13)



—Servo Brakes

Fig. A- 13

All of the forces applying and anchoring the primary shoe are transmitted through the shoe link, in a servo action, and also apply the secondary shoe, thus compounding its braking effect. When the drum is rotated backward, this compounding action of the shoes is reversed. When equipped with a double-end wheel cylinder (two opposed pistons), brake effectiveness can be substantially the same with either forward or reverse movement of the vehicle. With a single-end wheel cylinder (one piston), the brake is directionally effective. Since the secondary shoe performs more of the work in forward movement, it shows more lining wear.

Non-servo Type Brakes

In these brakes the shoes are so assembled that each shoe is separately anchored and their action is not compounded. On single cylinder brakes a "forward" or "leading" shoe is self-energized by the usual (forward) drum rotation while a "reverse" or "trailing" shoe is de-energized. When the drum is rotated backward, this action reverses, thus energizing the reverse shoe and de-energizing the forward shoe. The lining wear is unbalanced as a result of the shoes performing different amounts of work; the wear being more rapid on the forward acting shoe (Fig. A-14).

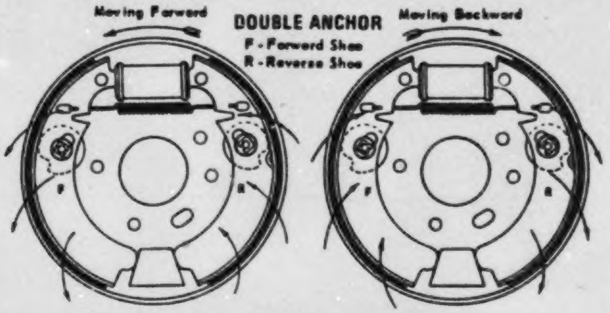


Fig. A-14 —Non-servo Brakes

Large two cylinder non-servo brakes, found on rear axles of heavier trucks, make use of two double-end wheel cylinders which enable the shoes to be anchored or actuated at either end. This arrangement is non-directional in effectiveness. With two-cylinder brakes, lining wear is balanced on both shoes (Fig. A-15).

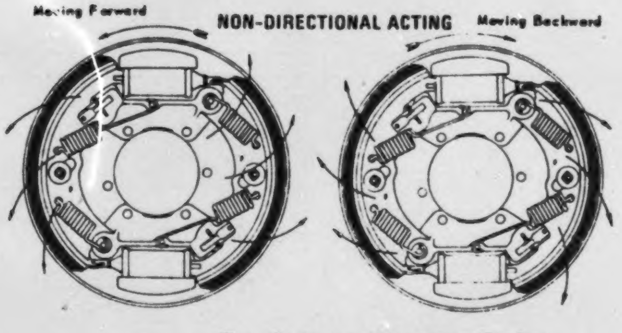


Fig. A-15 —Two Cylinder, Non-servo Brakes

Centre-plane (Total contact) Type Brakes

Found on the Chrysler vehicles from 1956 through 1962, these brakes are of the non-servo type. Both shoes are mounted within a "saddle" formed by two support plates with the principal purpose of localizing all stresses on the plane of the shoe webs. Anchors consist of block-type spacers located between the support plates in such a manner that the shoes are self-centering (Fig. A-16). The backing plates serve only as dust shields.

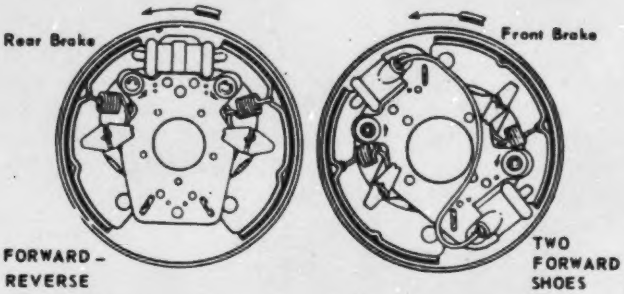


Fig. A-16 —Centre Plane Brakes

DISC BRAKES

Basic Operation

When the brake pedal is depressed, the hydraulic pressure from the master cylinder causes the disc brake pads to squeeze against both sides of a flat rotating disc--much like the brakes on a common bicycle (Fig. A-17). The linings may be molded or riveted to the metal shoe. The disc is cast, machined, and usually provided with fins in the centre between the two faces on which the shoes bear. Similar to fan blades, the function of the fins is to cool the disc. The disc is fastened at its centre, to the hub of the wheel. Fig. A-18 shows the basic parts on a disc brake system which include calipers, pistons, seals, boots, and rotors. Floating calipers have only one piston whereas the fixed calipers may have two to four pistons.

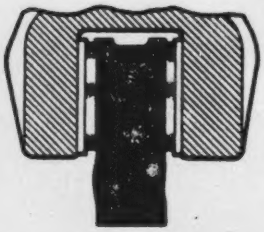


Fig. A-17 —Basic Disc Brake Operation

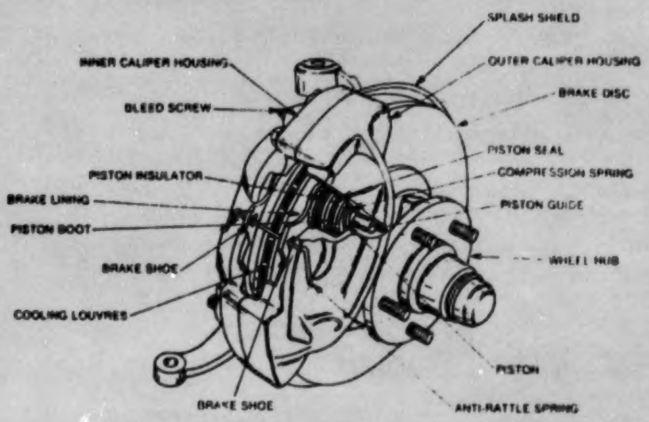

SPLASH SHIELD
INNER CALIPER HOUSING
OUTER CALIPER HOUSING
BRAKE DISC
BLEED SCREW
PISTON SEAL
PISTON INSULATOR
COMPRESSION SPRING
BRAKE LINING
PISTON GUIDE
PISTON BOOT
BRAKE SHOE
WHEEL HUB
COOLING LOUVRES
PISTON
BRAKE SHOE
ANTI-RATTLE SPRING

Fig. A-18 —Disc Brake Components

Advantages Over Drum Brakes

Disc brakes can generate higher braking forces than the drum brakes. This is due to the construction of the disc brake system where brake pads are directly opposite each other and act simultaneously. Usually high pressures can, therefore, be applied to the rotor without distorting it. The same forces in a drum brake system can cause the drum to become egg-shaped and sometimes they can even break the drum.

Disc brakes can make more severe stops more often than drum brakes without overheating. This is due to the fact that the dissipation of heat takes place more rapidly in disc brakes. Unlike the drum brakes, both sides of the brake discs (rotor) are exposed to the air allowing quicker heat dissipation.

Disc brakes are more efficient than drum brakes and less prone to brake fade due to water and dirt. This is due to the fact that both sides of a disc brake rotor are wiped clean and dry once every revolution. The rapid rotation of the disc tends to throw off water and foreign matter away from the braking surfaces. Due to their clamping action, the disc brakes are less apt to pull and generally produce more uniform straight-line stops. Rapid action, short pedal travel, and built-in self-adjusting feature are the other advantages of a disc brake system.

Caliper Basics

A caliper is basically a housing that resembles a hand that wraps around the edge of the rotor. A caliper assembly includes pistons, seals, springs, boots, fluid passages, and other parts. It is mounted on the steering knuckle. A four-piston caliper typical of most fixed caliper designs is shown in Fig A-19.

The number of pistons and the presence or absence of piston return springs are the only major differences in other caliper assembilies than shown in Fig. A-19. Disc brake shoes are also known as "pads" and the disc is also known as the "rotor." Hydraulic cylinders and pistons actuate the brake pads in the caliper. Because the pads contact the rotor (disc) at right angles, frictional drag carries the pads against the stops on the caliper but the rotation tends to thrust off the pads. Consequently, there is no pad energization or leverage and the disc brake is sometimes said to be "non-energized" and "automatic adjusting." When the actuating force is released disc brake pads merely relax at almost zero clearance. However, should the rotor "lateral run-out" exceed the normal 0.002" to 0.005" (0.05 to 0.13 mm), the pads will be "knocked back" much farther than is desirable for proper operation. This will require a long brake pedal stroke to establish pad contact with the disc during a stop. The non-energized disc brake requires more actuating force than on a drum brake of similar capacity, and, on all but the lightest vehicles, is used in conjunction with the power brake unit.

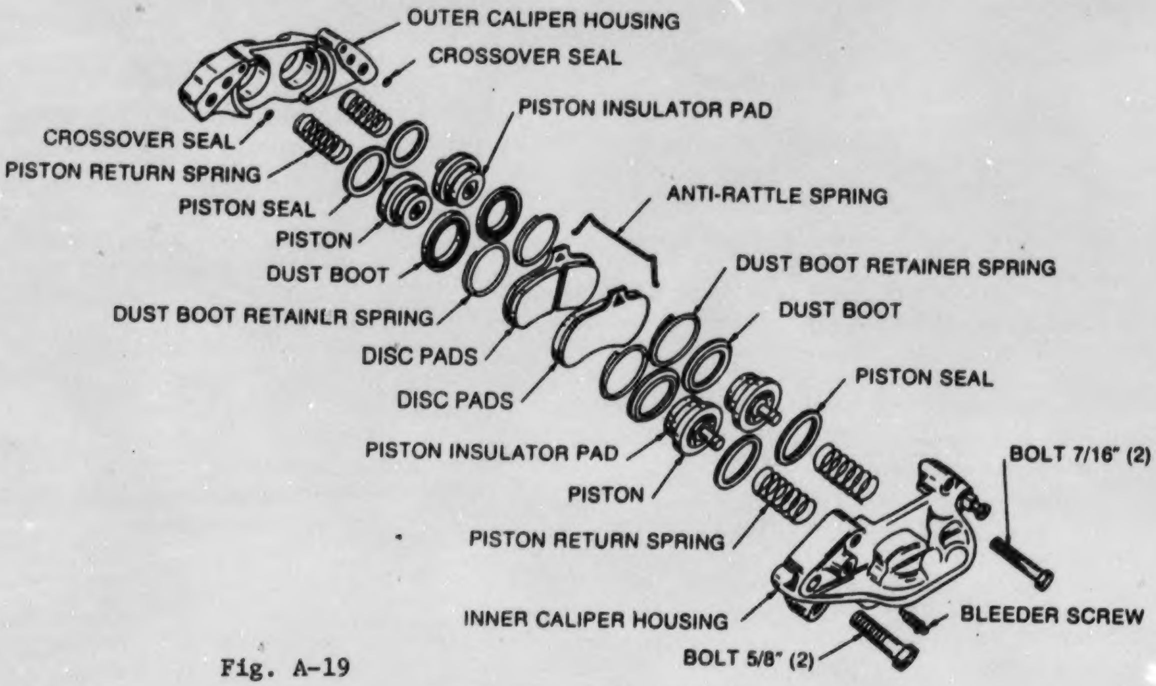

OUTER CALIPER HOUSING
CROSSOVER SEAL
PISTON INSULATOR PAD
CROSSOVER SEAL
PISTON RETURN SPRING
ANTI-RATTLE SPRING
PISTON SEAL
PISTON
DUST BOOT
DUST BOOT RETAINER SPRING
DUST BOOT RETAINLR SPRING
DUST BOOT
DISC PADS
DISC PADS
PISTON SEAL
PISTON INSULATOR PAD
BOLT 7/16" (2)
PISTON
PISTON RETURN SPRING
INNER CALIPER HOUSING
BLEEDER SCREW
BOLT 5/8" (2)

Fig. A-19

—Four Piston Caliper

There are two common types of disc brake caliper --fixed and floating (sliding). The basic function of both types is the same, but they use different approaches to do the job.

Fixed Caliper Design

As shown in Fig. A-20, a fixed caliper consists of a single U-shaped body with one or two pistons on each side. The fixed caliper is rigidly mounted straddling the rotor. Cylinder areas behind the piston are connected by the passages cast into the caliper body. Hydraulic pressure from the master cylinder forces the pistons on both sides of the caliper to squeeze the pads against the rotor, providing the desired braking action. The only drawbacks of the fixed caliper design are that it is expensive to manufacture due to its many components and the same complexity makes its servicing more difficult.

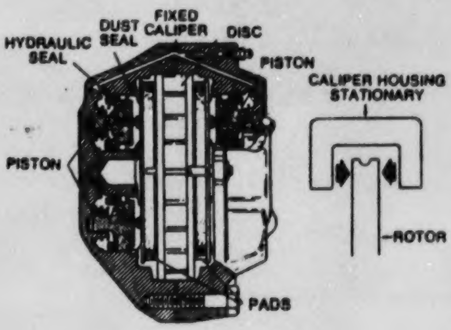


Fig. A-20 —Fixed Caliper Design

Floating (or Sliding) Caliper Design

A floating, or sliding caliper design is much simpler than its fixed caliper counterpart. It uses only one piston and when hydraulic pressure is applied to the piston, the equal and opposite force pulls the other caliper half and brake pad against the rotor.

As shown in Fig. A-21, the floating caliper straddles the rotor on a mount that permits limited caliper travel at right angles to the rotor. The hydraulic cylinder is located on the inboard side of the caliper housing. The instant the cylinder piston forces the inboard shoe against the inner surface of the rotor, the entire caliper assembly reacts in the opposite direction, thus applying the outboard shoe against the outer rotor surface. Braking force is equialized on both sides automatically by the reciprocal action of the caliper responding to actuating force applied in the hydraulic cylinder.

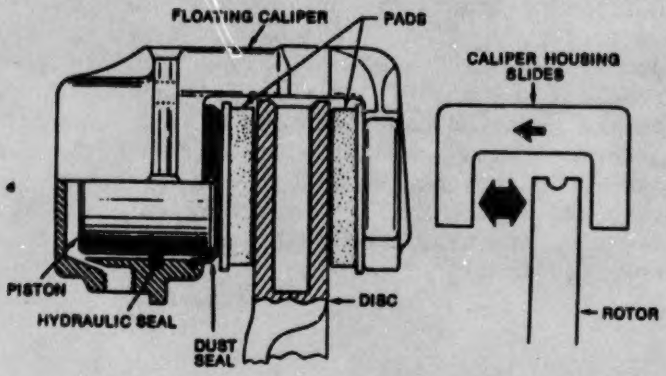

FLOATING CALIPER
PADS
CALIPER HOUSING SLIDES
PISTON
HYDRAULIC SEAL
DUST SEAL
DISC
ROTOR

Fig. A-21 —Floating Caliper Design

Despite some manufacturing variations, in most of the designs the caliper is free to "float" in and out slightly on the mounting bolts. Thus, when the brakes are not applied, there can be slight side-to-side movement. The mounting bolts, however, prevent the caliper from rotating with the rotor.

Four Wheel Disc Brakes

Whenever a brake pedal is depressed on a car in motion, it can be easily noticed that the front of the car dips down and the back rises up. The major braking effort is needed at the front of the car (Fig. A-22) due to weight transfer during braking.

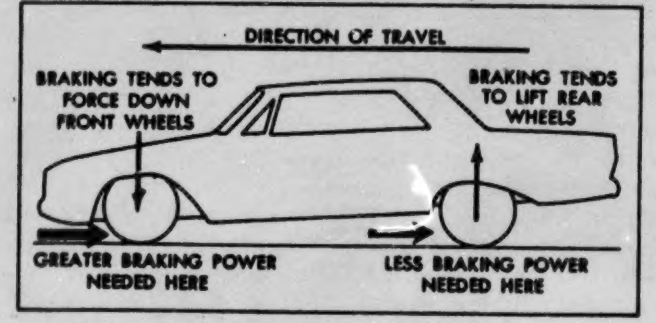

DIRECTION OF TRAVEL
BRAKING TENDS TO FORCE DOWN FRONT WHEELS
BRAKING TENDS TO LIFT REAR WHEELS
GREATER BRAKING POWER NEEDED HERE
LESS BRAKING POWER NEEDED HERE

Fig. A-22 —Braking Effort Distribution

It is estimated that the front wheels of a car handle about 75% of the braking effort. Manufacturing costs, lower requirements, and the parking brake designs are the criteria for installing the drum brakes in the rear and the disc type brakes in the front of a car.

Some imported cars, and domestic cars including Corvette, Imperial, Ford, and Lincoln-Mercury use disc brakes at all the wheels. The Lincoln-Mercury model uses rear disc brake pads for theparking as well as for the regular service brakes. Virtually all other makes and models use a separate drum brake set-up within the rear disc brake rotors to perform the parking brake function.

Brakes - Fundamentals

No. A-1 & A-2

Test #1

Name____ Date_____________ Grade_______

1. Theoretically liquids are not compressable. T or F

2. Pressure within a closed hydraulic system is the same at all points. T or F

3. Output force of a hydraulic piston can be increased by decreasing the piston area. T or F

4. Braking ability is affected by
   - A. Vehicle Weight
   - B. Vehicle Spped
   - C. Type of tires and road surface
   - D. All of the above

5. As the diameter of a drum or disc is increased, the braking ability will decrease. T or F

6. Servo self energizing primary brake linings have more surface area than secondary. T or F

7. On servo type brakes the braking pressure is transfered through an adjustable link between the primary and secondary shoes. T or F

8. Drum type brakes do not have the braking capacity of a disc type system. T or F

9. Disc brake systems can be classified as single piston, multipiston, fixed caliper and floating caliper. T or F

10. The rear wheel brakes do most of the braking when the car is moving forward. T or F

Auto Mechanics

Brakes - Fundamentals

No. A-3 Inspection

OBJECTIVE: After the completion of this exercise you will be able to perform a brake inspection.

EXPLANATION:

MATERIALS NEEDED: Safety glasses

TOOLS NEEDED: Wheel wrench, dust cap puller, diagonal side cutters, appropriate wrenches, drum removing tools.

References	Do
#1.	#1. Read suggested references
#2.	#2. Inspect brakes.
#3.	
#4.	
#5.	
#6.	
#7.	
#8.	

Drum Brakes

A brake drum is made of heavy cast iron and has a machined inner surface which is contacted by the brake lining during stopping action. The brake drum, provides the rubbing surface for the linings. The drums must be able to withstand high pressure without excessive flexing and to dissipate the large quantities of heat generated during brake applications. Road dust and water affect the efficiency of the brake drum working surface. To do a complete brake job, always turn the brake drums when the brake shoes are replaced. This is true even for a new replacement drum since its diameter must match that of the other drum on the same axle.

"Rock" each wheel to feel any loose "bumping" which suggests faulty wheel bearing adjustment or wear in steering and suspension components (ball joints, king pins, tie rod ends, shakcles, etc.) which could affect braking. To isolate looseness, span the clearance with the tip of the finger (wheel bearings, span between brake shield and drum flange) and feel for movement while rocking wheel.

Place the vehicle on jacks and remove the wheels and drums. With rear axle parking brakes, make sure that the cables are slack (released). Particularly with automatic brake adjusters, it may be necessary to back off the adjuster before removing the drum.

Brake drums should be visually inspected and measured with an accurate drum gauge, to see if they are within safe oversize limits. The following are some of the most common drum problems:

1. Scored Drum--caused by sand or grit in the brake assembly, or by very hard inferior grade brake lining. If the depth of the scoring exceeds 0.010" (0.25 mm), the drum may be turned. Fig.1.

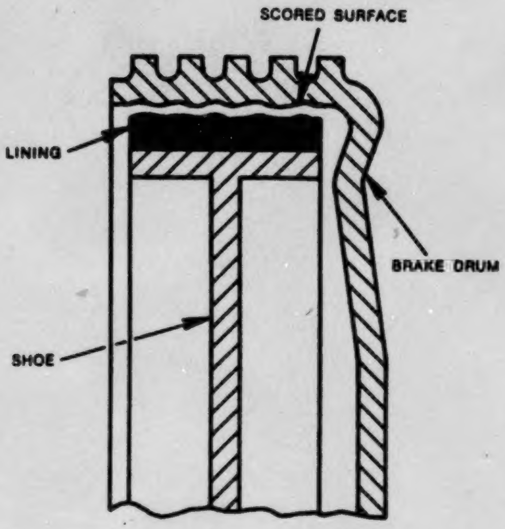

SCORED SURFACE
LINING
BRAKE DRUM
SHOE

Fig. 1 —Scored Drum Surface

2. Bell Mouthed Drum-- caused by poor support at the outside of the drum and occurs mostly on wide drums. Full drum-to-lining contact cannot be achieved and fading may be expected. Rebore or replace the drum if the inside diameter of the drum at the open end exceeds the inside diameter at the closed end by more than 0.010"/0.25 mm (Fig. 2)

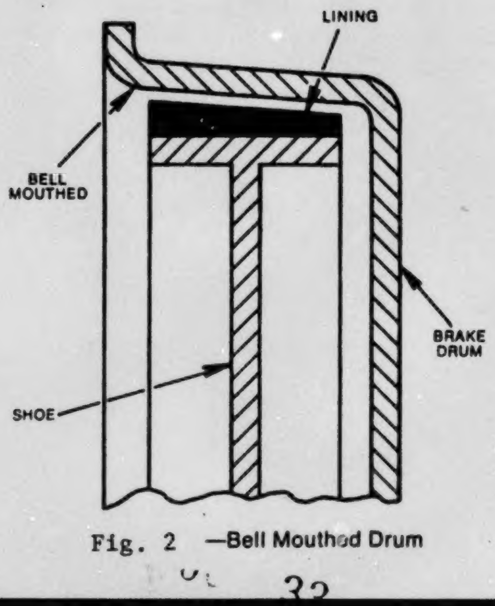

LINING
BELL MOUTHED
BRAKE DRUM
SHOE

Fig. 2 —Bell Mouthed Drum

3. Concave of Convex Drum--Rebore or replace the drum if the surface variance exceeds 0.005" (0.127 mm) on the side, (Fig. 3).

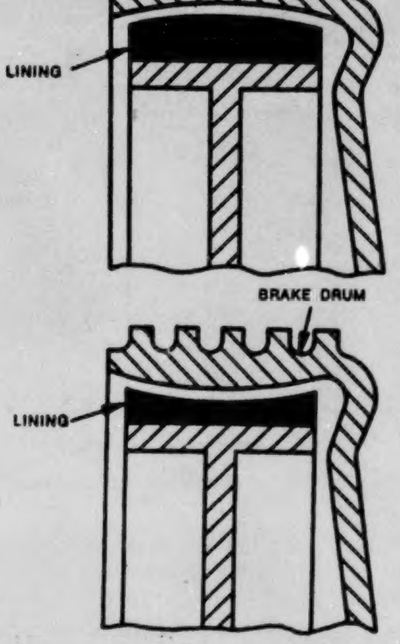


Fig. 3 —Concave and Convex Drum

4. Hard on Chill Spots--Sometimes called "islands" of steel in the cast iron surface, they result from a change in metallurgy caused by braking heat. Chatter, pulling, rapid lining wear, hard pedal, and noise will occur. The lining "blue," charred, or heavily glazed "glass-hard" surface is the result of severe overheating (Fig. 4). These spots can be removed by grinding, but may reappear as a result of heat. Then, replacement is recommended.

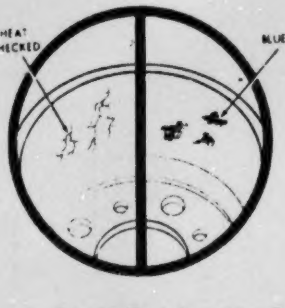


Fig. 4 —Drum "Blue" and/or Severely Heat-Checked

5. Cracks and Threaded Drum Surface--Very fine cracks in the drums at the bolt circle or at the outside of the flange may be difficult to find until after the drum has been turned. Do not use a cracked drum. An extremely sharp or chipped tool or too fast a lathe speed while turning, result in the threaded drum surface. Drums should, therefore, be reconditioned using a rounded tool and proper lathe speed. Check the edge of the drum surface around the mounting flange side for strain fractures and for the tool marks indicating a previous rebore. If it was rebored, it may have worn too thin for reuse (Fig. 5).

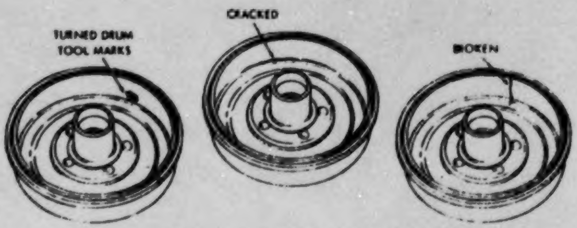


Fig. 5 —Turned, Cracked, and Broken Drum

6. Good condition visually, but occurrence of pull, grab, pedal vibration or "flight" ---
Gauge the drum to check the amount of eccentric distortion. Before the drum is removed, an out-of-round condition can be detected by adjusting the brake to a light drag and feeling the rotation of the drum by hand. The out-of-round or egg shaped condition can be caused by heating and cooling during brake operation. Drum should be replaced.

Best shop practice requires measuring every drum with a drum micrometer regardless of visual inspection. Gauge the diameter at various points, over the span of the surface, 45 degrees apart around the circumberence and at the bottom of the deepest groove to determine whether to rebore or to discard (Fig. 6). Eccentric (out-of-round) distortion should not exceed 0.010" (0.25mm). If the drums are not to be rebored when installing the new lining, prepare the old drum surfaces by dressing them with fine emery cloth or steel wool or by lightly grinding them on a drum lathe.

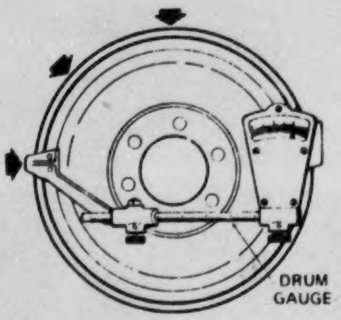


Fig. 6 —Accurately Measuring the Drum Diameter

Examine the shoe, anchor, support plate, and small parts for signs of looseness, wear or damage which could cause faulty shoe alignment. Check springs for spread or collapsed coils, twisted or nicked shanks and severe discoloration (Fig. 7). Operate the starwheel type automatic adjuster by prying the shoe lightly away from its anchor or by pulling the cable to make sure the adjuster advances easily, one notch at a time. The adjuster cables tend to stretch, star wheels and pawls become blunted over a long period of use. With the rear axle parking brake, pull on the cable and shoe linkage to make sure the movement does not bind and hold shoes expanded.

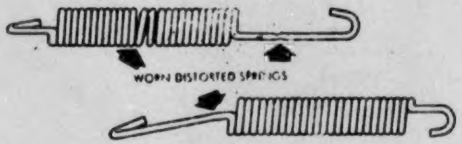


Fig. 7 —Inspect for Damaged Springs

Examine the wheel cylinders for fluid leakage whenever drums are removed. If the cylinder boot has an external lip, pull it back; with an internal boot, pull out the shoe push rod. A small amount of fluid seepage dampening the interior of the boot is normal, a dripping boot is not. For the greatest safety factor, cylinders should be reconditioned if lining is replaced.

Drum brake inspection should include the examination of wheel bearings and replacement of damaged wheel seals.

Examine condition and thickness of lining. Lining should not be glazed, soiled with grease or brake fluid or otherwise damaged. There should be a minimum of 1/32" of usable lining remaining (above rivet heads on riveted type) at the thinnest point.

Disc Brakes

Unlike the drum brakes, which have a "universal" standard for service with few exceptions, each type of disc brake and/or vehicle model must be serviced to a different set of specifications. Disc brake problems are mainly related to improper fits and distortions of flat surfaces which can be easily inspected, measured and diagnosed more accurately than the curved surfaces and shoe alignments of drum brakes.

Typical disc brake conditions that need careful inspection are:

1. Lateral Runout--A wobbly movement of the rotor from side to side as it rotates is called a lateral runout. Excessive lateral runout causes the rotor faces to knock back the disc pads and can result in chatter, excessive pedal travel, pumping or fighting pedal and vibration during the braking action, (Fig. 8). This condition can be due to a warped rotor, loose wheel bearing and, especially if symptoms develop immediately after sharp turns, deflection in steering or suspension components.

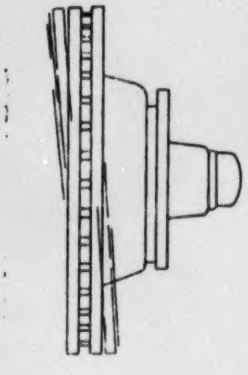


Fig. 8 —Excessive Runout—Disc Brakes

To check the actual rotor runout, first tighten the wheel spindle nut to a snug bearing adjustment, endplay removed. Tighten the nut to the specified rotor checking torque. Fasten a dial indicator on the suspension at a convenient place so that the indicator stylus contacts the rotor face about 1" (25 mm) from its outer edge (Fig. 9). Set the dial at zero. Check the total indicator reading (T.I.R.). While turning the rotor one full revolution. If the rotor is warped beyond the runout specifications, it is unlikely that it can be successfully remachined. Restore the specified bearing adjustment.

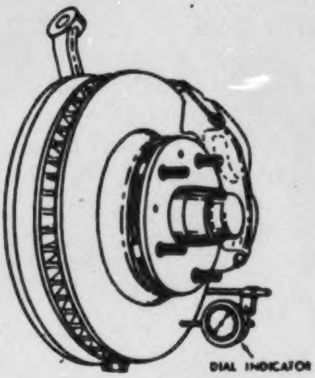


Fig.9 —Checking the T.I.R. With a Dial Indicator

2. Parallelism (lack of)--This refers to the amount of variation in the rotor thickness. Excessive variation can cause pedal vibration or fight, front end vibrations and possible "grab" during the braking action; a condition comparable to an "out-of-round brake drum." Check parallelism with a micrometer (Fig. 10). "Mike" the thickness at four or more equally spaced points, equi-distant from the outer edge of the rotor, preferably at mid-points of the braking surface. Parallelism, then, is the amount of variation between maximum and minimum measurements.

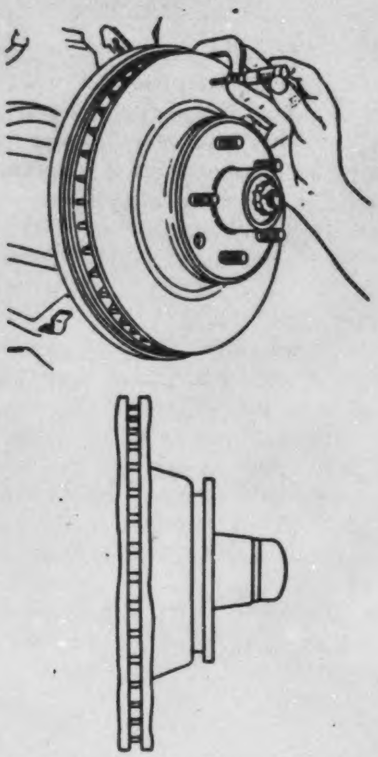


Fig. 10 —Rotor Parallelism—Disc Brakes

3. Surface or micro-inch finish, flatness, smoothness--Different from parallelism, these terms refer to the degree of perfection of the flat surface on each side of the rotor, i.e. the minute hills, valleys and swirls inherent in machining this span of surface. From the practical service viewpoint, actual micro-inch inspection is costly, time consuming and unnecessary; micro-inch specifications are designed to indicate the type of fine grinding wheel and the necessary precision of the grinder and the workmanship. In a visual inspection, the remachined surface should have a fine ground polish with, at most, only a faint trace of non-directional swirls. With new lining, this finish is needed to avoid pull and erratic performance and to extend the lining life.
4. Minimum Allowable Rotor Thickness-- Machining thinner than this limit could permit the rotor to wear past the safe discard point before the lining wears out. It could cause severe overheating, and as the lining becomes worn, it could cause the pads to be forced out far enough to jam the brakes. Whenever disc pads require replacement, check the minimum allowable thickness, parallelism and lateral runout as specified for each brake type and/or the vehicle model. After these checks, restore the wheel bearing adjustment.

5. "Rock each wheel, as with a drum brake, to feel loose bumping and form an opinion of the present wheel bearing adjustment and possible wear in the steering and suspension components. After placing the vehicle on jacks, remove the wheels and any inspection plates on the caliper. Compare the lining and rotor wear patterns, the rotor being more important as the lining shapes to the rotor surfaces. Also check for fluid leakage in the caliper.
6. Replace the pads and recondition the brakes when the disc pad lining is worn to 1/8" (3mm), the thickness of a nickel, above the metal backing plate, or when the disc pad lining is soaked in fluid or grease, or when it is loose on the backing. (Note: Some disc pads are provided with tell-tale metal tabs which make a noisy warning contact with the rotor after lining is worn to minimum safe thickness. This device will "sound" when the brakes are "off" and noise will stop when the brakes are applied). Recondition, if the tapered end-to-end lining wear causes a difference in thickness at the lining ends, exceeding 1/16" (1.5 mm) on fixed caliper types, 1/8" (3 mm) on floating caliper types. Allowing this condition to continue could permit pads to become wedged in the caliper housing (Fig. 11)

Grooving worn in the rotor surface does not indicate a need for reconditioning unless the braking performance has not been stable or the possiblility of noise is objectionable.

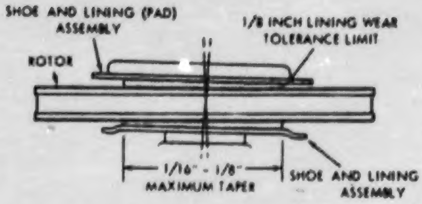

SHOE AND LINING (PAD) ASSEMBLY
1/8 INCH LINING WEAR TOLERANCE LIMIT
ROTOR
1/16" - 1/8" MAXIMUM TAPER
SHOE AND LINING (PAD) ASSEMBLY

Fig. 11 —Lining Wear Pattern

7. Should the rotor appear "blued or heat checked," inspect for severe overheating. On some brakes it is possible to easily remove the pads for inspection without other disassembly; on others, it may be possible to force the worn pads back far enough to inspect the lining surface. Before forcing back pads, remove about ½ of the fluid from the master cylinder reservoir. Recondition, if the lining surface is charred, blued, or hardended with a heavy glaze, or if the rotor is severely heat checked.
8. Recondition, if fluid leakage is sufficient to wet the lining or cause a definite loss of reservoir level between the vehicle lube intervals. The fluid seepage may cause some dampness or staining which has no immediate significance. For maximum safety, caliper cylinders should be reconditioned when disc pads are replaced.

Brakes - Fundamentals

No. A-3 Inspection

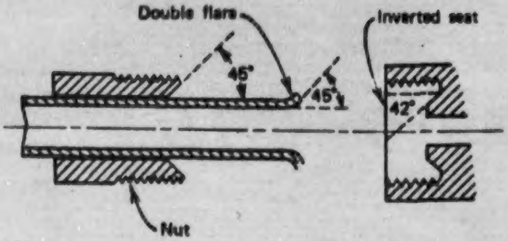
Worksheet # 1

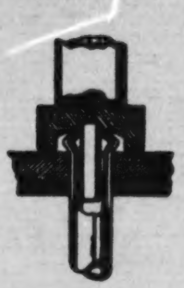
Name______________________________ **Date**_______________ **Grade**________

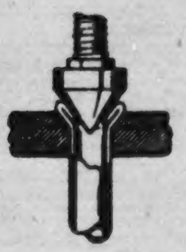
Directions: Refer to service manual for the make, year and model car which is being serviced.

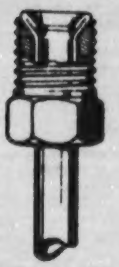
1. Lining material OK ________________ Replace ________________
2. Lining contamination (fluid, oil etc.) Yes __________ No __________
3. Brake hardware Good ____________ Bad ____________
4. Wheel cylinder or caliper leakage Yes __________ No ____________
5. Rotor surface condition Good ___________ Bad ____________
6. Rotor thickness Min. Spec. F__________ Actual Spec. F_________
   R__________ R_________
7. Drum surface condition Good __________ Bad ____________
8. Drum diameter Max Spec. F__________ Actual Spec. F_________
   R__________ R_________
9. Front seal condition Good ___________ Bad ____________
10. Rear seal condition Good ___________ Bad ____________

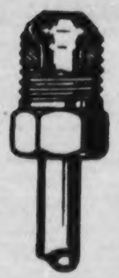
Instructor's Initials__________


Double flare
Inverted seat
45°
45°
42°
Nut


STEP 1

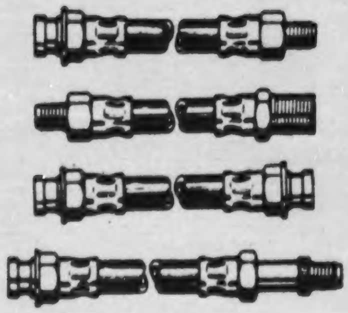

STEP 2

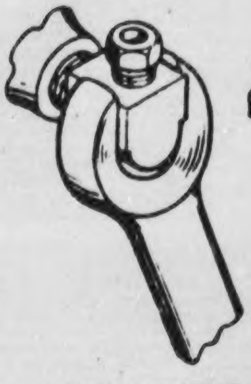

DOUBLE FLARING

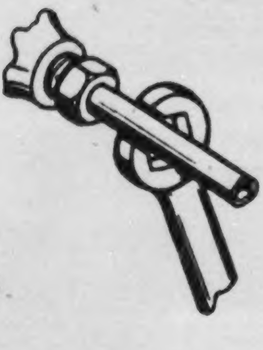

CHAMFER TYPE FLARING

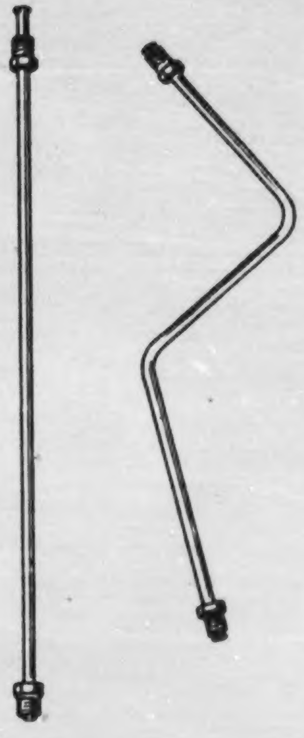
BRAKE FLUID

LINES & HOSES




PROTECTING FITTING AGAINST DAMAGE


USING TUBE NUT WRENCH



REFERENCE

The texts chosen were selected because they are in current use by the instructors who compiled this manual. You should have a copy of at least one in your shop.

The text books are to be used as references for each exercise in this book. For each exercise you will find a number followed by page numbers. Look up the book number on this list and the page numbers will correspond to the exercise on which you are working. For example, if you find #4. 103-111 in the reference section, you would check this reference list and find that book No. 4 is Auto Mechanics by H. E. Ellinger. In that book, pages 103-111 will apply to the exercise you are working.

	TEXT	AUTHOR	PUBLISHER
1.	Auto Service and Repair 1975	Stockel	Goodheart - Willcox
2.	Auto Mechanics Fundamentals 1974	Stockel	Goodheart - Willcox
3.	Automotive Encyclopedia 1975	Toboldt - Johnson	Goodheart - Willcox
4.	Auto Mechanics 1977 Second Edition	Ellinger	Prentice - Hall
5.	Automotive Mechanics 1970 Sixth Edition	Crouse	McGraw - Hill
6.	The Auto Book 1974	Crouse	McGraw - Hill

Auto Mechanic's
Brakes - Lines, Fluid and Hoses
No. B - Index

B-1 Safety
B-2 Inspect and Refill Brake Fluid
B-3 Bleeding Hydraulic Brakes
B-4 Double Flaring Steel Brake Tubing
B-5 R & R Steel Brake Line
B-6 R & R Brake Hose

Auto Mechanics
Brakes - Lines, Fluid and Hoses
No. B-1 Brake Safety

OBJECTIVE: After completion of this exercise the student will be familiar with brake system safety.

EXPLANATION:

MATERIALS NEEDED: Safety glasses

TOOLS NEEDED:

References	Do
#1.	#1. Read safety information sheet
#2.	#2. Complete safety quiz
#3.	
#4.	
#5.	
#6.	
#7.	
#8.	

Brake - Lines, Fluid and Hoses

No. B-1 Safety

Information Sheet # 1

Spilled brake fluid should always be cleaned up right away. Brake fluid harms auto finishes and also is very slippery when on the floor. Water is the best way of rinsing away brake fluid.

To be safe and decrease the time it takes to bleed a brake system, always loosen each of the bleeders and retighten before bleeding.

Brake linings contain 33% to 73% asbestos. Breathing asbestos dust may cause asbestosis and cancer. During brake servicing, an air purifying respirator should be worn during all procedures starting with the removal of the wheels and including reassembly. Prior to disassembly, dust should first be cleaned from all brake parts using an industrial vacuum cleaner equipped with a high efficiency filter system. Under no circumstances should compressed air or dry brushing be used for cleaning.

Brake pliers, shoe retaining spring tool and safety glasses should be used when removing brake retaining springs and hardware. Springs may slip and present a hazard for personnel.

CAUTION: Never put ordinary oil in a brake system. Ordinary oil will cause rubber parts in the system, such as the piston cups, to swell and go to pieces. This could cause complete brake failure and lead to a fatal accident. Never use anything but the brake fluid recommended by the car manufacturer!

Brakes - Lines, Fluid and Hoses

No. B-1 Brake Safety

Test #1

Name____Date__________Grade__________

1. Removing dust and dirt from the brake linings and backing plates should be done with water. T or F

2. To insure safety and a good brake bleeding job, all bleeders should be loosened and retightened before beginning the bleeding process. T or F

3. Brake fluid will not harm auto finishes. T or F

4. Water is the best way of cleaning up brake fluid spills. T or F

5. Care should be exercised when relieving pressure on power assist systems and removing brake retaining springs to prevent personal injury. T or F

Brakes - Lines, Fluid and Hoses

No. B-2 Inspect and Refill Brake Fluid

OBJECTIVE: After the completion of this exercise you will be able to inspect brake fluid levels and refill if necessary.

EXPLANATION:

MATERIALS NEEDED: Safety glasses, brake fluid

TOOLS NEEDED: Necessary wrenches or screwdrivers

References	Do
#1. --	#1. Study references assigned
#2. --	#2. Do worksheet on brake fluid level inspection.
#3. --	
#4. p. 437	
#5. --	
#6. --	
#7. --	
#8. --	
Wagner Brake Manual pp. 20-21	

No. B-2 Inspect & Refill Brake Fluid

Information Sheet # 1

HANDLING AND STORING BRAKE FLUID

The following basic rules should be applied when handling and storing brake fluid.

1. Keep the brake fluid clean. Do not get any foreign material in the fluid.
2. Be very careful to keep any petroleum product (gasoline, kerosene, oil, grease, etc.) from getting into the brake fluid.
3. Use only clean containers for dispensing brake fluid. Do not use containers contaminated with dirt, oil, grease, rust, etc.
4. Always cover or cap brake fluid containers when not actually dispensing the fluid. If containers are left open or uncovered, the fluid tends to absorb moisture from the air.
5. Discard old brake fluid drained from the hydraulic system. Used brake fluid is contaminated to some degree.
6. Store brake fluid containers in a clean, dry place.

CHANGING BRAKE FLUID

Due to Usage

As a result of use, brake fluid loses some of its original qualities and may become contaminated. When performing major brake work, it is good practice to flush the hydraulic system to remove old fluid and replace it with clean brake fluid. If any of the hydraulic system parts are corroded or the fluid is discolored, the hydraulic system also should be flushed to remove old fluid, and then filled with clean brake fluid.

DUE TO CONTAMINATION soft or swollen rubber parts in the hydraulic system are an indication that the brake fluid is contaminated. If this happens ...

. . . . . The old fluid should be drained from the system.

. . . . . All cups and seals should be replaced.

. . . . . The hydraulic system should be flushed with clean brake fluid or alcohol.

. . . . . The system should be refilled with clean brake fluid.

FLUID LEVEL INSPECTION

Should the fluid level in the reservoir fall below the master cylinder intake port(s), air will enter the system. Since it would take a number of brake applications to pump in sufficient air to run out of the pedal, this condition is not so dangerous as fluid boiling. Usually it is only necessary to refill the reservoir and purge the system of air by slowly stroking the pedal a few times. If this action fails to restore a "solid" pedal, the system must be bled.

Always clean off the top of the fluid reservoir before opening it. Restore the fluid level to 3/8" (10mm) below the top of the reservoir, as shown in Fig. 1. Periodic inspection of the brake fluid should be carried out at the regular vehicle lubrication intervals. Heavy duty or super heavy duty (standard) fluids should be changed at the time of brake relining. Extreme high temperature (550°F/288°C) fluids should be changed at 6-month intervals.

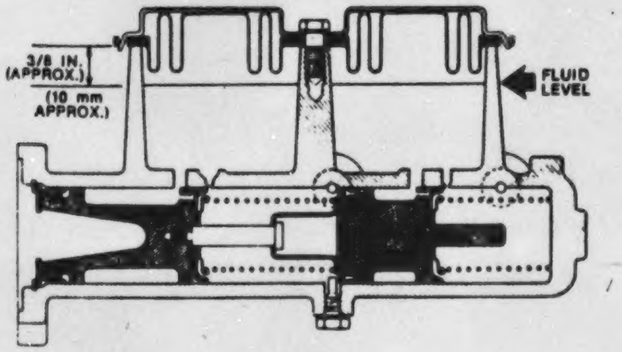


Fig. 1 —Brake Fluid Level Inspection

Brakes - Lines, Fluid and Hoses

No. B-2 Inspect and Refill Brake Fluid

Worksheet #

Name____________________________________**Date**________________**Grade**_________

1. Refer to the assigned references for instruction on inspecting and refilling the master brake reservoir.

2. Check, visually, the condition of the brake fluid. If it is anything but clean looking, change the brake fluid. Refer to the WagnerBrake Manual Page 20 -- under changing brake fluid for instructions.

3. Is the fluid level up to specifications?

4. When filling brake fluid reservoir, do not spill on the painted finish of the car.

Instructor's Initials____________

Auto Mechanics

Brakes - Lines, Fluid and Hoses

No. B-3 Bleeding Hydraulic Brakes

OBJECTIVE: After the completing of this exercise you will be able to bleed a hydraulic brake system.

EXPLANATION:

MATERIALS NEEDED: Safety glasses, brake fluid

TOOLS NEEDED: Bleeder wrench

References	Do
#1. pp.29-25 to 29-27	#1. Read references assigned.
#2. pp. 346-347	#2. Do worksheet on bleeding hydraulic brakes.
#3. pp. 535-537	
#4. pp.452-453	
#5. pp. 527-528	
#6. --	
#7. --	
#8. --	
Wagner Brake Manual	
pp.31-35	

Lines, Fluid and Hoses

No. B-3 Bleeding Hydraulic Brakes

Information Sheet # 1

The brake hydraulic system must be free of air to function properly. Any air in the system is compressed when the pressure is applied, resulting in a spongy brake pedal. Air is lighter than brake fluid, so air bubbles will float on top of the fluid in wheel cylinders or work back into the master cylinder. Air can enter the system if any of the hydraulic parts are disconnected or if the brakes are operated with the master cylinder fluid level very low.

Flushing procedure is similar to bleeding except that a greater quantity of brake fluid is discharged from each bleeder point to be sure that all of the old dirty or contaminated fluid is removed. Brake fluid, or alcohol followed by brake fluid can be used for flushing the system. Alcohol, however, should not be used unless wheel cylinders and calipers are to be reconditioned after flushing. Any flushing fluid trapped in the system will dilute new brake fluid.

Bleeding, Draining, and Flushing

Bleeding is a service procedure which, at low pressure, introduces fresh brake fluid into the system and consequently expels the air bubbles and the old aerated fluid.

To completely drain the system, open the bleeder screws and pump the pedal slowly until only air is expelled. If the fluid reservoir has a diaphragm type seal, first remove it. If the vehicle is equipped with a pressure metering valve, hold it open. To catch the fluid, slip a hose over each bleeder screw and drain into containers. Never let the brake fluid spill on a car's finish. Accidental spilling of the brake fluid on the car-finish should be flushed with water; don't wipe it with a towel or a rag.

Bleeding Locations

Depending upon the point at which the hydraulic system was opened to air, bleeding may be required at all four wheels and the master cylinder; or it may be required at only a wheel or two (Fig. 1). If both tubes were disconnected from the master cylinder (one tube on single system master cylinder), or if air was introduced into the system through low fluid level in both master cylinder reservoirs (one reservoir on single system master cylinder), bleeding is then required at all four wheels and the master cylinder.

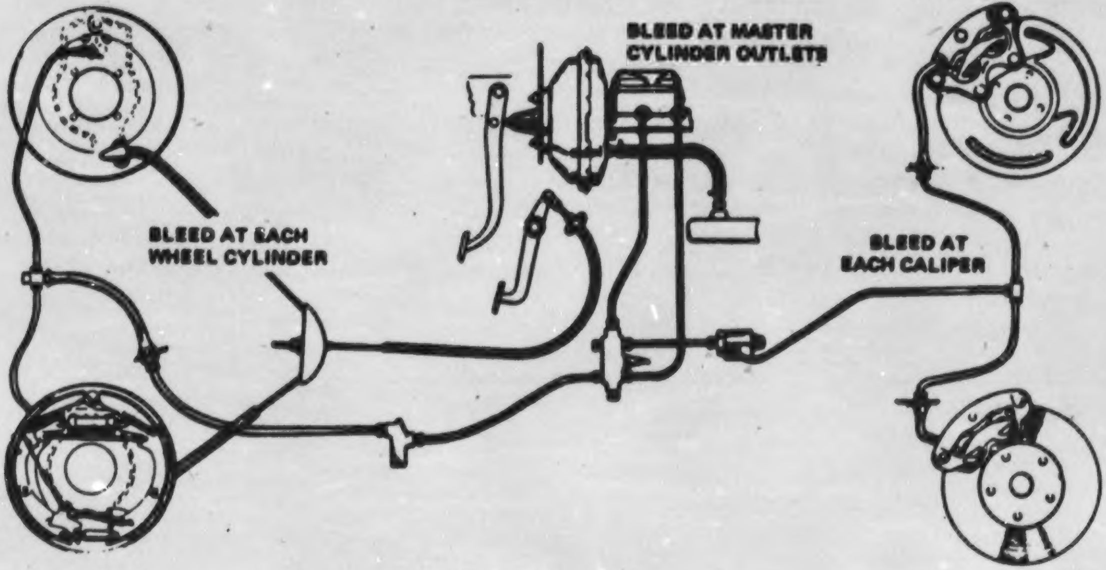

BLEED AT MASTER CYLINDER OUTLETS
BLEED AT EACH WHEEL CYLINDER
BLEED AT EACH CALIPER

Fig. 1 —Typical Bleeding Locations

On the other hand, only the rear wheels or the front wheels must be bled, as appropriate, if the tube serving that set of wheels was disconnected at the master cylinder, or if air was introduced into the system through low fluid level in only the master cylinder reservoir serving that set of wheels.

Bleeder screws are located strategically at high points on the wheel cylinders, and it is through them that the air and fluid are actually expelled. Normally, a bleeder screw is installed in each drum brake wheel cylinder, in each disc brake caliper, adjacent to the outlet port of some master cylinders, and on some combination valves on the disc brakes. Some bleeder screws have a threaded passage and a protective dust cap screw which must be removed before a drain hose is attached to the bleeder screw.

Pressure Bleeding

Pressure bleeding can be preformed by one man and in a shorter period of time than manual bleeding. For dispensing hydrualic brake fluid under pressure, use a modern pressure bleeder system as shown in Fig. 2. This bleeder system consists of a Fluid-bal, a bleeder drain hose, and three adapters--universal thread type, tandem cylinder type, and universal clamp chain type.

Fill the bleeder unit with clean brake fluid and bring the unit to a working pressure of 15-20 psi (103-138 kPa). Clean master cylinder cover and gasket seat. Fill the master cylinder with brake fluid to within ½ inch (13 mm) from the top. Install the selected adapter (Fig. 3) with gasket. Push the female quick-disconnect coupler on hose, over male coupler on the adapter, making sure that the coupling sleeve slips down to locked position. Open the fluid supply valve.

Then bleed the system in the following order (on power brakes; engine off, no vacuum present):

a) Master cylinder, if provided with a bleeder screw.
b) Power unit, if provided with bleeder screw. If there are two screws, bleed the higher first.
c) Wheel cylinders, starting with the brake farthest from the master cylinder. When a two-cylinder brake has two bleeder screws, bleed the lower first.

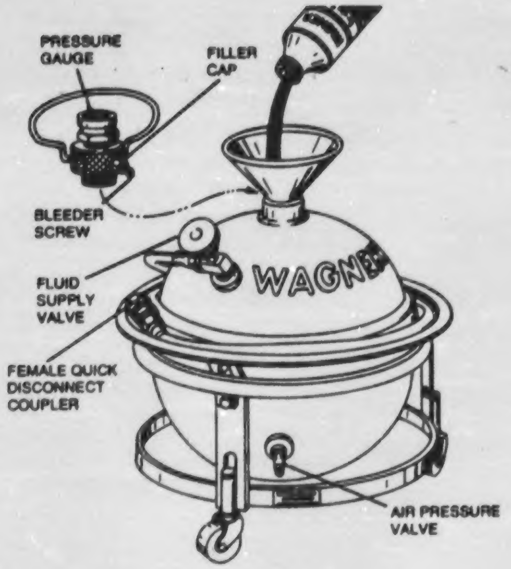

PRESSURE GAUGE
FILLER CAP
BLEEDER SCREW
FLUID SUPPLY VALVE
FEMALE QUICK DISCONNECT COUPLER
WAGNER
AIR PRESSURE VALVE

Fig. 2 —Modern Brake Bleeder

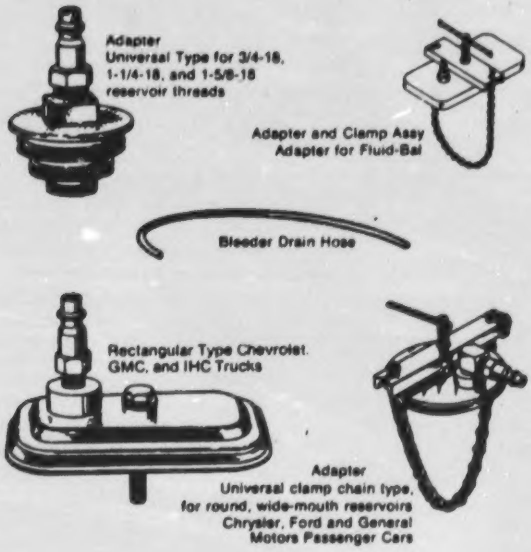

Adapter
Universal Type for 3/4-18, 1-1/4-18, and 1-5/8-18 reservoir threads
Adapter and Clamp Assy
Adapter for Fluid-Bal
Bleeder Drain Hose
Rectangular Type Chevrolet. GMC, and IHC Trucks
Adapter
Universal clamp chain type, for round, wide-mouth reservoirs Chrysler, Ford and General Motors Passenger Cars

Fig. 3 —Bleeder Unit Adapters

Bleeding Sequence

Bleed the hydraulic system in the following order:

a) Master cylinder bleeder screws, if so equipped; or by "cracking" the outlet tube nuts at the master cylinder while a helper applies moderate pressure of the brake pedal.
b) Bleeder screw on the combination valve, if so equipped.
c) Wheel cylinders and calipers in succession, beginning with the wheel farthest from the master cylinder and working up to the closest one.
d) Two cylinder wheel brakes:if two bleeder screws are provided, bleed the lower cylinder first.

METHODS OF BLEEDING

Manual Bleeding

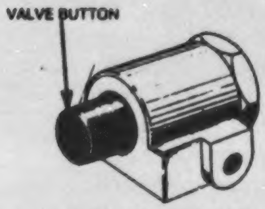
Manual bleeding is a two-man operation. Starting at the wheel farthest from the master cylinder, the service-man opens and closes the bleeder screws and observes the emission of air bubbles while his assistant pumps the brake pedal slowly in order to move the fluid through the system and expel trapped air. A piece of hose is slipped over the bleeder screw and the free end is inserted into a jar partially filled with brake fluid. The service-man can determine accurately when all air from the system has been purged by observing when bubble-free fluid flows from the hose. Air in the system is visible as bubbles emerge from the end of the hose inserted in the fluid, as the pedal is depressed.

Keeping the end of the hose inserted in fluid will prevent the accidental admission of air to the system when the bleeder screw is open. Pedal pumping action must be done SLOWLY to prevent any undue build-up of pressure and increase in turbulence. Manual bleeding, unlike pressure bleeding, requires that the fluid level in the master cylinder be checked and replenished periodically. If the level drops below the intake port, air will enter the system. The bleeder screw should be open only when the pedal is depressed and closed before the pedal is released. Residual pressure valves in the system will not hinder bleeding. The metering valve (if so equipped) should be deactivated to properly bleed front disc brakes.

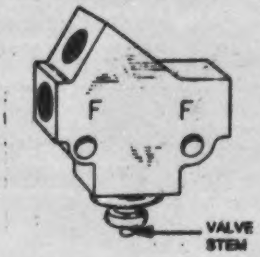
Metering Valves

Type "A"—Button Valve, Push-in Only:
12-25 lb (53-111 N) Spring Pull.

Type "B"—Stem Valve, Push-in, or Pull-out:
22-35 lb (98-156 N) Spring Pull,
0.060 inch (1.5 mm) minimum travel.



(A) Push-In Only



(B) Push-In or Pull-Out

The valve may be held open by hand, masking tape, or preferably a special tool designed for the purpose. Keeping the valve open, bleed the front brakes. The valve should not be closed until both front wheels are bled.

To bleed, slip the bleeder hose on the bleeder screw and submerge the hose-end in brake fluid contained in a partially filled jar. Open the bleeder screw one turn. Allow the fluid to flow unitl air bubbles no longer appear in the jar, then close the bleeder screw. It is not necessary to close the supply valve until bleeding is completed at all the bleeder screws.

Any cylinder or tubing without a bleeder screw can be bled at any tube connection by loosening the tube nut one turn. Catch dripping fluid in a shop towel.

To disconnect the pressure bleeder, close the supply valve, cover the quick-disconnect coupler with shop towel to prevent the fluid from dripping on car finish and pull on the coupler sleeve to uncouple. Be sure to fill the master cylinder reservoir with brake fluid to within 3/8" - 1/2" (10-13 mm) from the top before replacing the reservoir cap.

Surge Bleeding

This method includes both manual and pressure bleeding, and deliberately creates a churning (higher pressure) turbulence in wheel cylinders so that any remaining air can be drawn off in the form of aerated fluid. It is important to remove all possible air before surging; thus this method is never used unless the routine manual or pressure bleeding method proves inadequate.

Following simple procedure is recommended for surge bleeding:

1. Bleed the brakes at all wheels in a usual manner.
2. At each wheel cylinder, in turn, open the bleeder screw and press the brake pedal down sharply several times. Close the bleeder screw. This action creates a turbulence in each cylinder, forcing out practically all of the remaining trapped air.

Chev.-GMC, w/Midland low input power unit.
Bleed at 35-40 psi (240-275 kPa) working pressure.
Then surge bleed power unit, engine running.

1. Pump the pedal to its greatest height, at least 3 strokes.
2. Maintain the foot pressure and open and close the bleeder screw on the power unit while depressing the pedal only 3/4 stroke.
3. Repeat 1 & 2 until clear fluid bleeds from the screw.
4. Also bleed at the wheels in the same manner.

CAUTION: After bleeding the brake system by any of the above methods, road test the car to insure proper operation of the braking system.

Brakes - Lines, Fluid and Hoses

No. B-3 Bleeding Hydraulic Brakes

Worksheet # 1

Name________________________________Date______________Grade________

1. Refer to the assigned references for instructions on bleeding hydraulic brakes.

2. Which method are you using to bleed the brakes? (Manual or Pressure)

3. Why would you surge bleed a hydraulic brake system?

4. Bleed the brake system.

5. Have instructor check job.

Instructor's Initials________

Auto Mechanics

Brakes- Lines, Fluid and Hoses
No. B-4 Double Flaring Steel Brake Line Tubing

OBJECTIVE: After the completing this exercise you will be able to double flare steel tubing, used for brake lines.

EXPLANATION:

MATERIALS NEEDED: Safety glasses, steel tubing, tube nuts

TOOLS NEEDED: Double flaring tool

References	Do
#1. pp. 5-3 to 5-4 p. 29-24	#1. Study reference assigned.
#2. --	#2. Do worksheet on flaring brake lines.
#3. --	
#4. --	
#5. pp.424-426	
#6. --	
#7. --	
#8. --	
Wagner Brake Manual	
p.21	

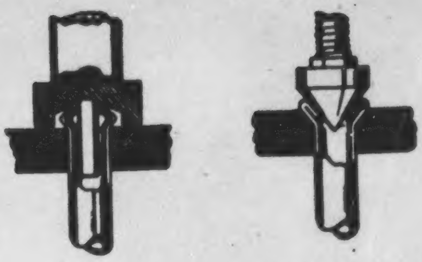
Brakes - Lines, Fluid and Hoses

No. B-4 Double Flaring Steel Brake Line Tubing

Information Sheet # 1

Flaring

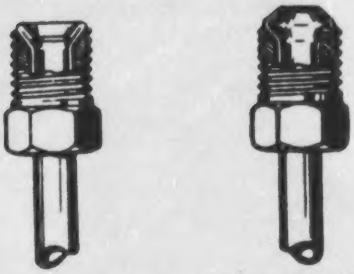
Before flaring, the tube nuts should be assembled on the tubing. The ends should be flared by a double flaring type tool. For a chamber type flare, only step 1 of Fig. 1 is needed. Fig. 2 shows the completed flares.



STEP 1

STEP 2

Fig. 1 - Flaring Brake Tubes



DOUBLE FLARING

CHAMFER TYPE FLARING

Fig. 2 -- Completed Flares

Any metal chips or dirt particles should be removed, before assembly.
CAUTION: Protect eyes.

Brakes - **Lines, Fluid and Hoses**

No. **B-4 Double Flaring Steel Brake Line Tubing**

Worksheet #1

Name_____________________________________**Date**_________________**Grade**_________

1. Refer to the assigned references for information on how to double flare steel brake line.
2. Double flare the steel brake line.
3. Check brake lines for splitting and proper seating area.
4. Have instructors inspect work.

Instructor's Initials___________

Auto Mechanics

Brakes - Lines, Fluid and Hoses
No. B-5 R & R Steel Brake Line

OBJECTIVE: After the completion of this exercise you will be able to replace a steel brake line.

EXPLANATION:

MATERIALS NEEDED: Safety glasses, brake fluid, steel brake line

TOOLS NEEDED: 6 pt., tubing nut wrenches

References	Do
#1. --	#1. Read assigned references
#2. p. 344	#2. Do worksheet on R & R steel brake line.
#3. --	
#4. --	
#5. p. 515	
#6. --	
#7. --	
#8. --	
Wagner Brake Manual pp. 21-22	

No. B-5 R & R Steel Brake Line

Information Sheet # 1

Steel Tubing

The hydraulic lines are usually made of steel tubing, flared at both ends to accommodate male fittings. They are available in different lenghts and diameters (most common sizes being 3/16" (4.8 mm), ¼" (6.4mm) and, 5/16" (7.9 mm) O.D.) and can be bent to conform to the needs of the job (Fig. 1).

Fig. 1 -- Steel Tubing for Hydraulic Lines

Most tubes are made of double-walled, welded steel coated to resist rust. The ends are double flared or have a chamfer type flare to guard against leakage. Pipe couplings create high pressure seals; a tube nut forcing each flared tube end against a matching seat in its line fitting. It is important to start the male fitting into the wheel cylinder or hose using fingers only to prevent cross-threading and subsequent stripping of the threads.

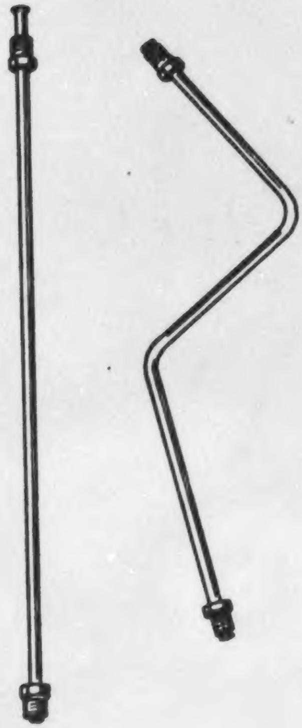


Fig. 1 -- Steel Tubing for Hydraulic Lines

Servicing

The correct size and type of wrench should be used when tightening or loosening the hydraulic fittings (Fig. 1). To avoid distortion, a spare tube nut should be screwed into a female fitting. On fittings requiring gaskets, new copper gaskets should always be used since the old copper gaskets take a set and may not form a seal if re-used.

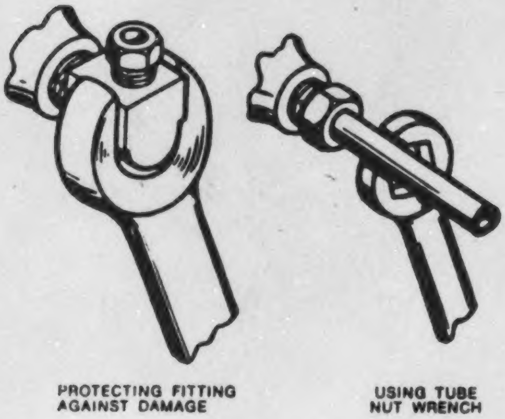

PROTECTING FITTING AGAINST DAMAGE
USING TUBE NUT WRENCH

Fig. 1 -- Tightening Hydraulic Fittings

Brakes - Lines, Fluid and Hoses

No. B-5 R& R Steel Brake Line

Worksheet # 1

Name____________________________________**Date**________________**Grade**_________

1. Refer to the references assigned for instruction on how to R & R a steel brake line.
2. Remove defective brake line from vehicle.
3. Install new steel brake line.
4. Bleed brakes.
5. Have instructor inspect job.

Instructor's Initials________

Auto Mechanics
Brakes- Lines, Fluid and Hoses
No. B-6 R & R Brake Hose

OBJECTIVE: After the completion of this exercise you will be able to replace a brake hose.

EXPLANATION:

MATERIALS NEEDED: Safety glasses, brake fluid

TOOLS NEEDED: Necessary flare nut wrenches

References	Do
#1. --	#1. Study the assigned references.
#2. --	#2. Do worksheet on replacing a brake hose.
#3. --	
#4. --	
#5. --	
#6. --	
#7. --	
#8. --	
Wagner Brake Manual pp.22-23	

Information Sheet #1

Hydraulic Hoses

Hoses form a flexible link between the brakes and the car frame or the body. They must withstand high fluid pressures without expansion and must be free to flex during spring deflection and wheel turns without damage. Hoses come in different sizes and lengths and it is important to use a correct size hose for a given application. A hose which is too long will rub against the chasis or any other part and eventually wear through its cover (Fig. 1). In extreme cases, this abrasion can wear through the hose and cause a hydraulic failure. A hose which is too short can break in tension. Constant exposure to weather and aging might result in hardening and cracking of a hose. Especially critical are the ends connected to the brass couplings. Blisters in a hose suggest seepage in the hose joint which has penetrated underneath the outer hose covering (Fig. 2). Never take a chance with a faulty hose; replace it.

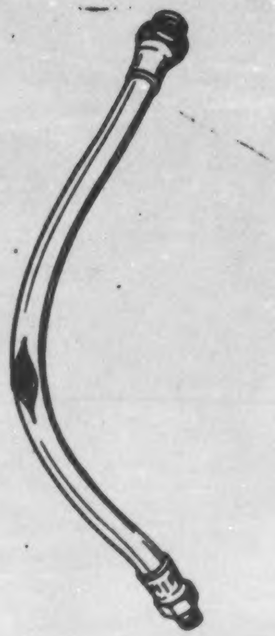


Fig. 1 -- Damaged Brake Hose

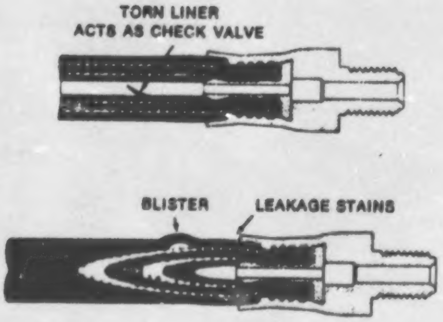


Fig. 2 -- Torn Liners and Blisters in Brake Hose

Servicing

Most hoses have a male fitting on one end and a female fitting on the opposite end. Disconnect the female end first. Remove the clip or the jam nut fastening down the female end and then unscrew the male end, making sure the replacement hose is equal in length to the removed hose. When installing, connect the male hose end first and if a copper gasket was used, replace with a new gasket. Then install the female end in a position which will turn the curve of the hose away from any point of chafing contact. Do not fail to replace a hose suspension spring when used. Check for interference with hose during spring deflection and rebound, and while wheels are steered to extreme left and right. Any interference must be removed by loosening the female end of the hose and repositioning it. Never twist a brake hose by tightening the male end after the female end is installed.

Brakes - Lines, Fluid and Hoses

No. B-6 R & R Brake Hose

Worksheet # 1

Name__________________________________**Date**________________**Grade**________

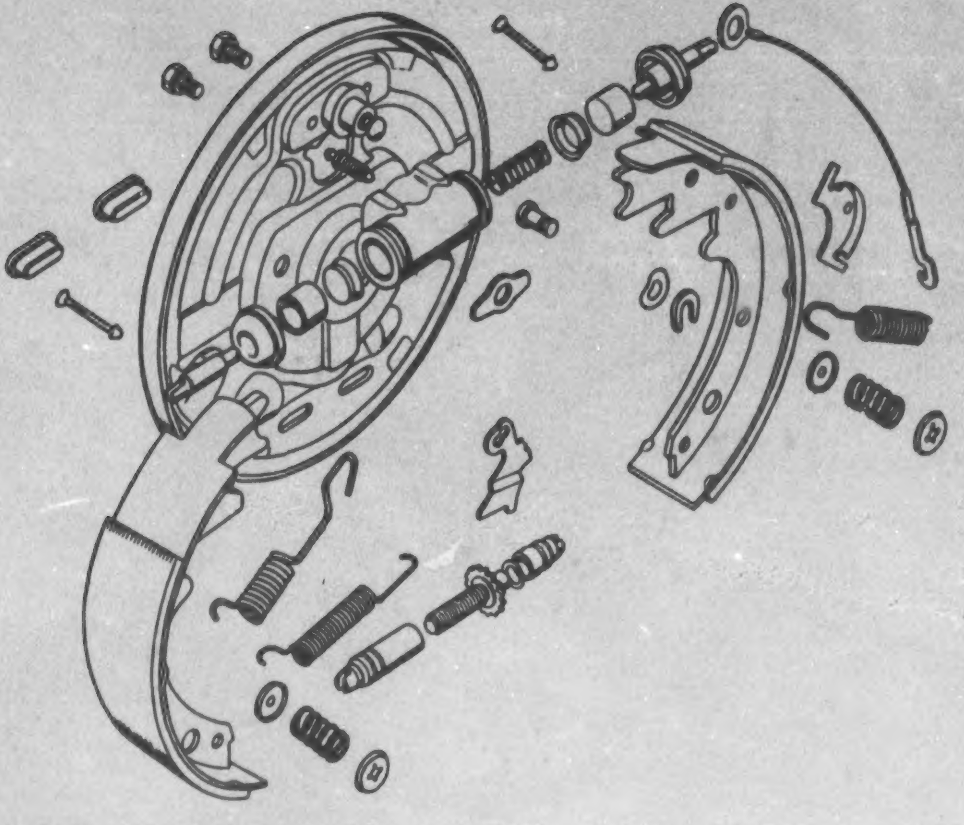
1. Refer to the assigned references for instructions on R & R brake hose.

2. R & R brake hose.

3. Have instructor inspect work.

Instructor's Initials__________

Drum-Brakes



REFERENCE

The texts chosen were selected because they are in current use by the instructors who compiled this manual. You should have a copy of at least one in your shop.

The text books are to be used as references for each exercise in this book. For each exercise you will find a number followed by page numbers. Look up the book number on this list and the page numbers will correspond to the exercise on which you are working. For example, if you find #4. 103-111 in the reference section, you would check this reference list and find that book No. 4 is Auto Mechanics by H. E. Ellinger. In that book, pages 103-111 will apply to the exercise you are working.

TEXT	AUTHOR	PUBLISHER
1. Auto Service and Repair 1975	Stockel	Goodheart - Willcox
2. Auto Mechanics Fundamentals 1974	Stockel	Goodheart - Willcox
3. Automotive Encyclopedia 1975	Toboldt - Johnson	Goodheart - Willcox
4. Auto Mechanics 1977 Second Edition	Ellinger	Prentice - Hall
5. Automotive Mechanics 1970 Sixth Edition	Crouse	McGraw - Hill
6. The Auto Book 1974	Crouse	McGraw - Hill

AUTO MECHANICS

BRAKES - DRUM BRAKES

No. C - Index

C-1 SAFETY

- #1 - General Safety
- #2 - Jacking Instructions

C-2 SPECIAL TOOLS

C-3 DRUM BRAKE DESIGN

C-4 BRAKE PARTS

- #1 - Wheel Cylinders
- #2 - Brake Shoes and Linings
- #3 - Brake Hardware
- #4 - Brake Drums

C-5 DRUM BRAKE REPAIR AND SERVICE

- #1 - General Drum Brake Servicing Procedures
- #2 - Design Applications

AUTO MECHANICS

BRAKES - DRUM BRAKES

No. C - INTRODUCTION

Drum type brakes have a long history of use in the automobile. In the past, most automobiles were equipped with four-wheel drum brakes. With the advent of the disc-type brake, the use of drum brakes has decreased with most systems now using drums only on the rear axle.

Although the overall use of drum brakes has changed over the years, the need for servicing has not. Proper repair of all drum brake designs is still a necessary skill for mechanics. The following material is an indepth look at drum brake repairs.

Auto Mechanics
Brakes - Drum Brakes

No. C-1 Safety

OBJECTIVE: Upon completion of this unit, the student will be able to practice safe work habits while servicing drum brake systems.

EXPLANATION: This unit will involve the safe work habits that should be used when working on a drum brake system.

MATERIALS NEEDED: Safety glasses

TOOLS NEEDED:

References	Do
#1.	1. Read information sheets.
#2.	2. Check with instructor.
#3.	
#4.	
#5.	
#6.	
#7.	
#8.	

Brakes - Drum Brakes

No. C-1 Safety Information Sheet #1

GENERAL SAFETY

A. **Asbestos Dust Hazard Warning**

Brake linings contain 33% to 73% asbestos. Breathing asbestos dust may cause abestosis and cancer. During brake service and air purifying respirator should be worn during all procedures starting with the removal of the wheels and including reassembly. Prior to disassembly dust should first be cleaned from all brake parts using an industrial vacuum cleaner equipped with a high efficiency filter system. Under no circumstances should compressed air or dry brushing be used for cleaning.

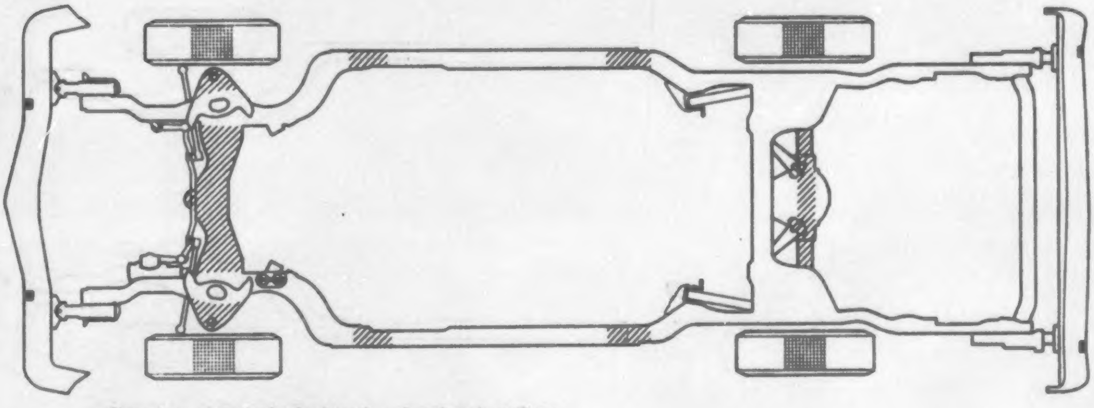
B. Safety glasses should always be worn during disassembly, cleaning and reassembly of braking system components.

C. Using the proper tool when working on brakes can prevent injury to your hands in particular when removing and replacing springs.

D. Safety in brake system can also cover your liability in the job you do. Be careful that all work leaving be complete. Don't do a half-way job when working on the braking system.

E. **Raising and Supporting a Vehicle**

Since most brake work requires that the wheels and drums be removed, you must raise the car off the floor. This task is usually done with a floor jack. Whenever you raise a car with a floor jack you must place the jack in the right spot. You would not want the car to slip off the jack, nor would you want to place the jack where it could damage any parts under the car. Many different kinds of frames and suspension systems are in use. Therefore, you should be sure to check the manufacturer's service manual to find the areas under the car that provide a safe, solid place for you to position a jack.



Drawing of a typical chassis, showing locations where it is safe to place a jack or car stands (courtesy Chevrolet Service Manual, Chevrolet Motor Division).

Jacks are made to raise cars, not to support them. Working on a car that is held off the floor by a jack is a sure way of getting hurt, since the car can slide off the jack. Anytime you raise a car from the floor, even for a few minutes, place car stands under the car to support its weight. For this, too, you should check the manufacturer's service manual. At the bottom of the previous page is a typical drawing found in service manuals showing areas where it is safe to place a jack or car stands.

Though there are many different areas under a car where stands can be positioned, there are only two ways to support a car. One is by the frame, and the other is by the suspension system. When a car is supported by the frame, the wheels are free to drop down to the limits of their suspension systems. This means you have more room to work on the brakes since the wheels drop down below the fenders. Supporting a car by the frame gives you another advantage. The car stands are not right behind the backing plates and can't get in your way.

Brakes - Drum Brakes

No. C-1 Safety Information Sheet #2

JACKING INSTRUCTIONS

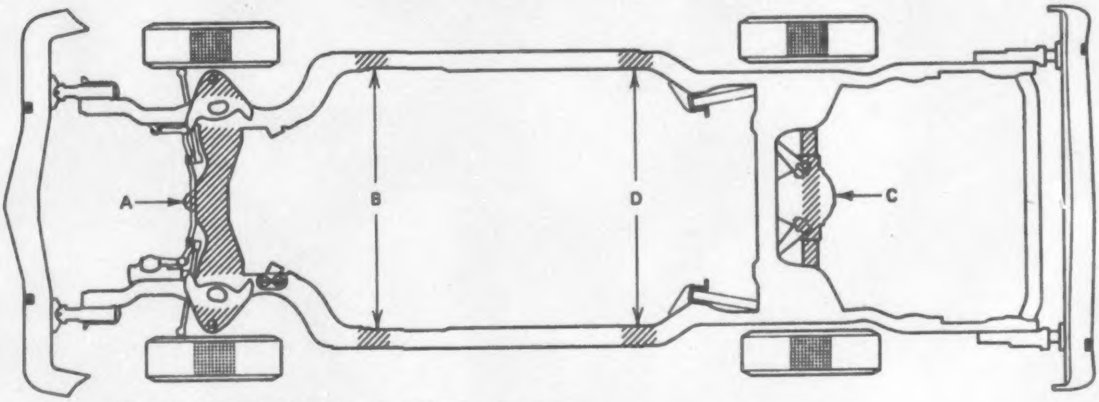
The following steps outline the procedure for raising a car with a jack and supporting it with car stands placed under the frame. You should check the manual for the correct lifting and support points for the car on which you are working.

FRONT

1. Roll a jack under the front of the car. Raise the jack slightly, and adjust its position so that it is centered under the front crossmember.
2. Operate the jack to raise the car until the wheels clear the floor by about six inches (18 cm).
3. Place the car stands under the frame side rails just behind the bend in the frame. (See position B.) Raise the car stands as close as possible to the frame.
4. Lower the jack so the car is supported by the stands.
5. Remove the jack.

REAR

1. Roll a jack under the rear of the car. Raise the jack slightly and adjust its position so that it is centered under the rear axle housing. (See position C.)
2. Operate the jack to raise the car until the wheels are clear of the floor by at least 10 inches (25 cm).
3. Place car stands under the frame side rails just ahead of the bend in the frame. (See position D.) Raise the car stands as close as possible to the frame.
4. Lower the jack so the car is supported by the stands.
5. Remove the jack.



Drawing of a typical frame, showing locations for raising a car with a jack (A and C) and positions where car stands should be placed (B and D) for supporting the car by the frame (courtesy Chevrolet Service Manual, Chevrolet Motor Division).

No. C-2 Special Tools for Drum Brake Service

OBJECTIVE: Upon completion of this unit the student will be able to identify and select the proper tools for drum brake service.

EXPLANATION: Before attempting brake system service, knowledge of special tools is important to reduce the chance of damaging new and reuseable parts.

MATERIALS NEEDED: Safety glasses

TOOLS NEEDED:

References	Do
#1.	1. Read assigned references.
#2.	2. Read information sheets.
#3.	3. Check with instructor.
#4. Chapter 27 pp.441-446	
#5.	
#6.	
#7.	
#8.	

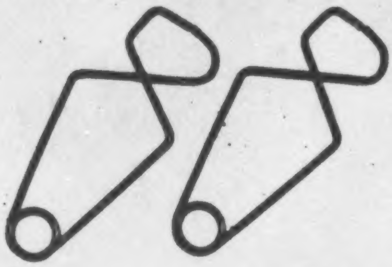
No. C-2 Special Tools for Drum Brake Service

Information Sheet #1

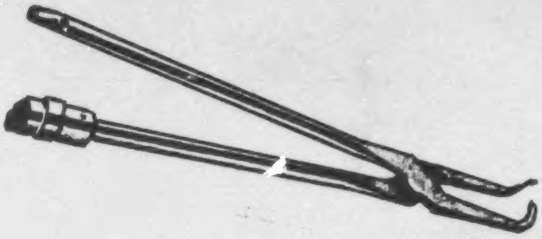
TOOLS

Special tools are available on the market to assist the mechanic in the removal and installation of automotive drum brakes. Tools such as wheel cylinder hones, brake piston clamps, "C" washer pliers, universal spring pliers, brake adjusting spoons, drum micrometer, piston puller, brake set qauge, bleeder, wrench, retaining spring tool, etc. These tools and more can decrease the amount of time to complete a brake job when used properly. They can also help you to avoid damage to the parts which could cause them to be unsafe in use.

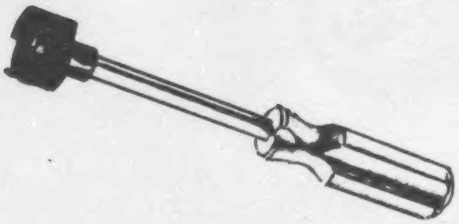
Brake Piston Clamp Set



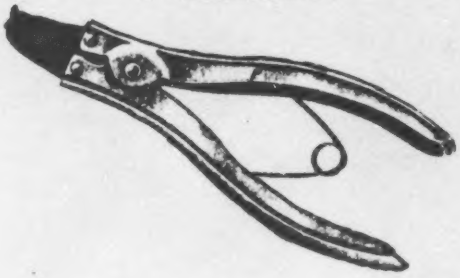
Universal Brake Spring Pliers



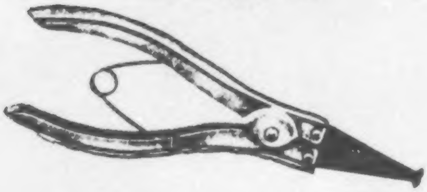
Shoe Retaining Spring Tool



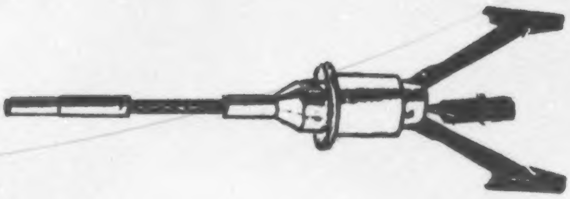
"C" Washer Pliers



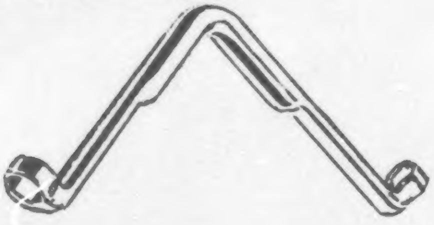
Brake Piston Puller



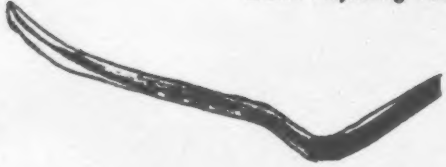
Brake Cylinder Hone

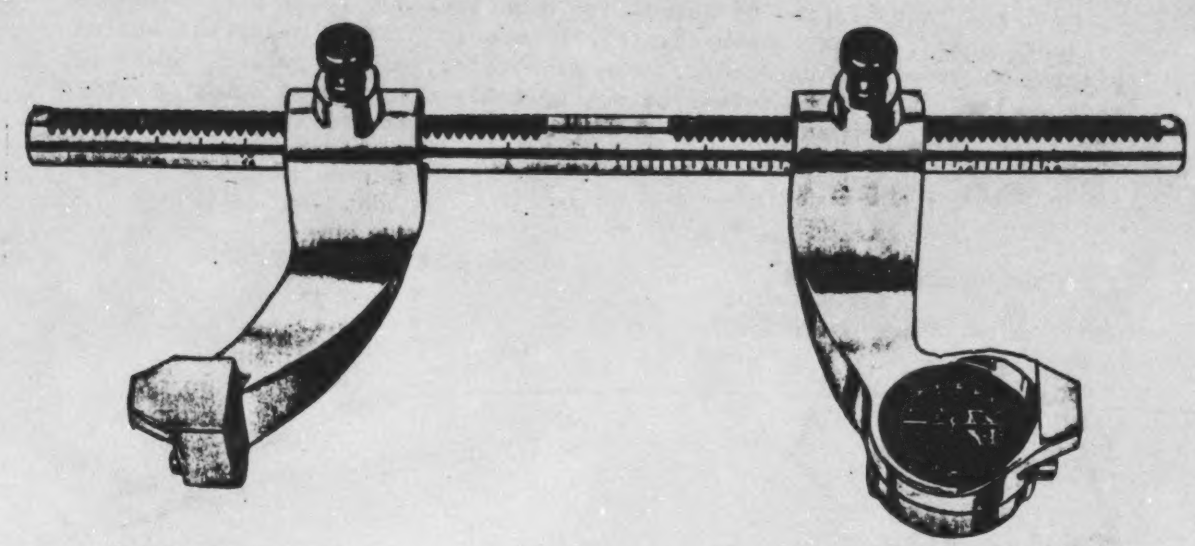


Brake Bleeder Wrench

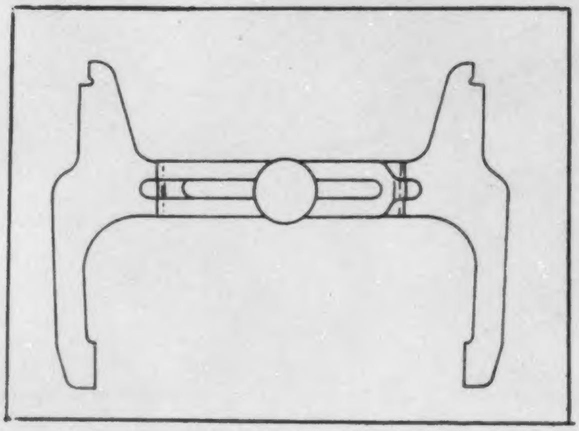


Brake Adjusting Tool.





A typical brake drum micrometer



Typical drum-to-brake shoe clearance gauge

Auto Mechanics
Brakes - Drum Brake

No. C-3 Drum Brake Design

OBJECTIVE: Upon completion of this unit, the student will be able to identify and apply knowledge of drum brake design during the servicing of drum brakes.

EXPLANATION: This unit will explain the basic fundamentals of drum brake systems, including principles of operation, hydraulics and parts nomenclature.

MATERIALS NEEDED: Safety glasses

TOOLS NEEDED:

References	Do
#1. Chapter 29 pp. 1-3	1. Read assigned references.
#2. Chapter 18	2. Read information sheets.
#3. Pp. 509-512, 517-518	3. Check with instructor.
#4. Chapter 27 pp. 435	
#5. Chapter 40 pp. 506-508, 511	
#6. Chapter 41 pp. 570-571	
#7.	
#8.	

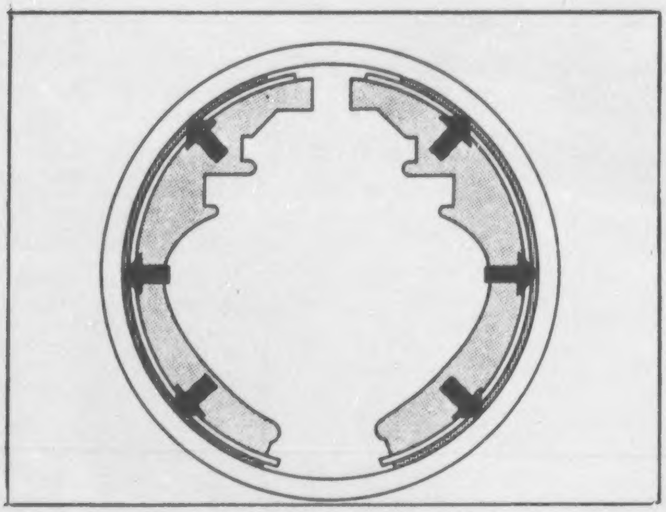
PRINCIPLES OF OPERATION

When brakes are applied to a wheel in motion, the friction between the rotating drum and the brake lining tries to pull the shoes around with the drum. The anchor pin prevents the shoes from rotating and causes the pulling effort to tug the shoes out into tighter contact with the drum. The positions of the anchor pin and of the star wheel adjuster determine the ease with which the shoes yield to this pulling action. By carefully positioning these parts, the manufacturer can obtain high braking forces without requiring the driver to exert much effort on the brake pedal. This is the self-energizing feature of this type brake. It uses friction together with the placement of parts to increase the force holding the shoes against the drum.

The motion of the rotating drum jams the secondary shoe against the anchor pin. The same motion of the drum pulls the primary shoe away from the anchor pin and forces it against the star wheel adjuster. The star wheel adjuster passes this push along to the bottom of the secondary shoe. This extra push adds to the force holding the secondary shoe against the drum. In this manner the primary shoe "serves" the secondary shoe. This is called servo action.

When a car is moving backward, the drum rotation is reversed; the function of the shoes is also reversed. The secondary shoe is pulled away from the anchor pin and is forced against the star wheel adjuster. The push is then passed along to the bottom of the primary shoe. This action adds to the force holding the primary shoe against the drum.

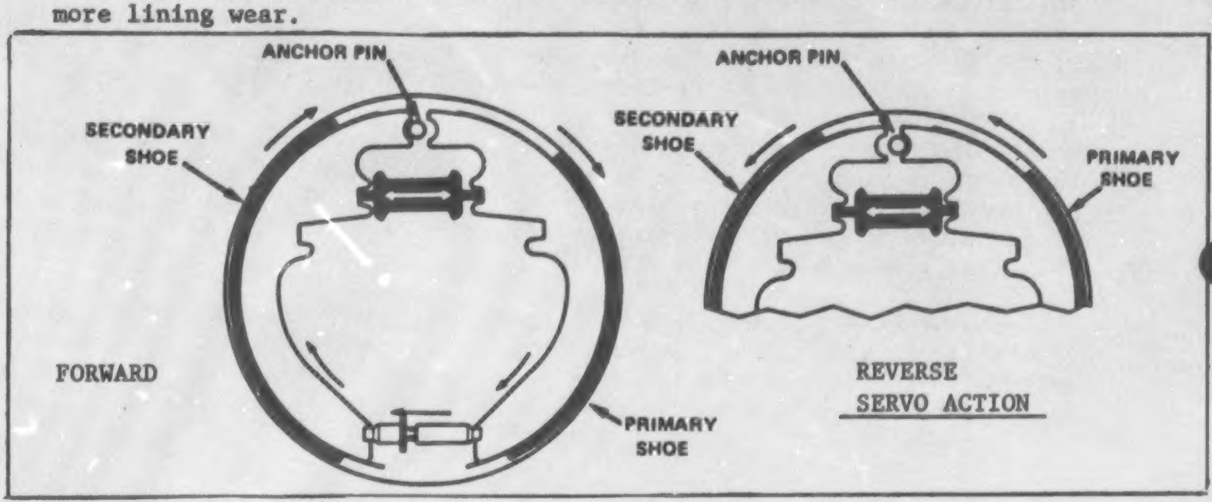
The drum brake being studied provides servo action regardless of the direction of wheel rotation. This means that the brake is as effective in stopping a vehicle moving backward as it is in stopping one moving forward. Since servo action is provided in both directions, the brake is termed duo-servo.



Braking force of brake shoes on a brake drum.

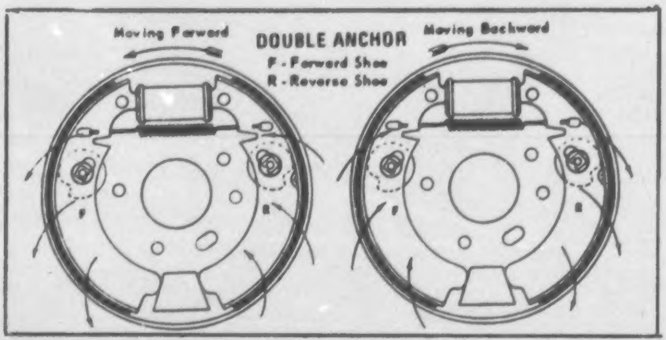
Servo Type Brakes

In these brakes the shoes are so assembled that they form a compound, "primary" and "secondary", shoe unit joined at one end by an adjustable floating link. The drag of a normal (forward) drum rotation causes the primary shoe to leave its anchor and holds the secondary shoe anchored. All of the forces applying and anchoring the primary shoe are transmitted through the shoe link, in a servo action, and also apply the secondary shoe, thus compounding its braking effect. When the drum is rotated backward, this compounding action of the shoes is erversed. When equipped with a double-end wheel cylinder (two opposed pistons), brake effectiveness can be substantially the same with either forward or reverse movement of the vehicle. With a single-end wheel cylinder (one piston), the brake is directionally effective. Since the secondary shoe performs more of the work in forward movement, it shows more lining wear.


ANCHOR PIN
SECONDARY SHOE
PRIMARY SHOE
FORWARD
ANCHOR PIN
SECONDARY SHOE
PRIMARY SHOE
REVERSE
SERVO ACTION

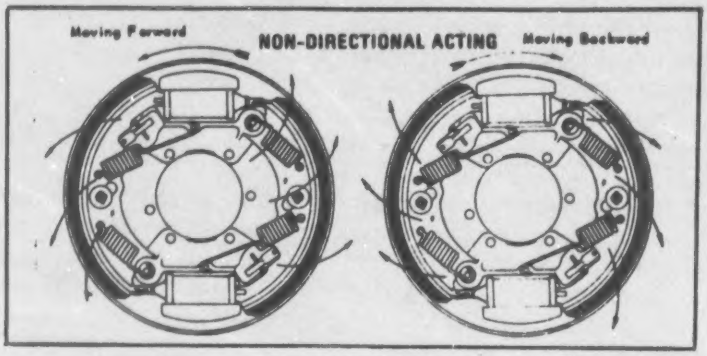
Non-servo Type Brakes

In these brakes the shoes are so assembled that each shoe is separately anchored and their action is not compounded. On single cylinder brakes a "forward" or "leading" shoe is self-energized by the usual (forward) drum rotation while a "reverse" or "trailing" shoe is de-energized. When the drum is rotated backward, this action reverses, thus energizing the reverse shoe and de-energizing the forward shoe. The lining wear is unbalanced as a result of the shoes performing different amounts of work; the wear being more rapid on the forward acting shoe.


Moving Forward
DOUBLE ANCHOR
F - Forward Shoe
R - Reverse Shoe
Moving Backward
F
R
F
R

Non-servo Brakes

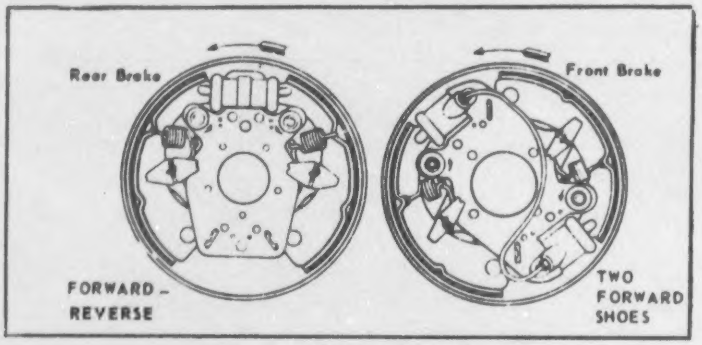
Large two cylinder non-servo brakes, found on rear axles of heavier trucks, make use of two double-end wheel cylinders which enable the shoes to be anchored or actuated at either end. This arrangement is non-directional in effectiveness. With two-cylinder brakes, lining wear is balanced on both shoes.


Moving Forward
NON-DIRECTIONAL ACTING
Moving Backward

Two Cylinder, Non-servo Brakes

Centre-plane (Total contact) Type Brakes

Found on the Chrysler vehicles from 1956 through 1962, these brakes are of the non-servo type. Both shoes are mounted within a "saddle" formed by two support plates with the principal purpose of localizing all stresses on the plane of the shoe webs. Anchors consist of block-type spacers located between the support plates in such a manner that the shoes are self-centering. The backing plates serve only as dust shields.

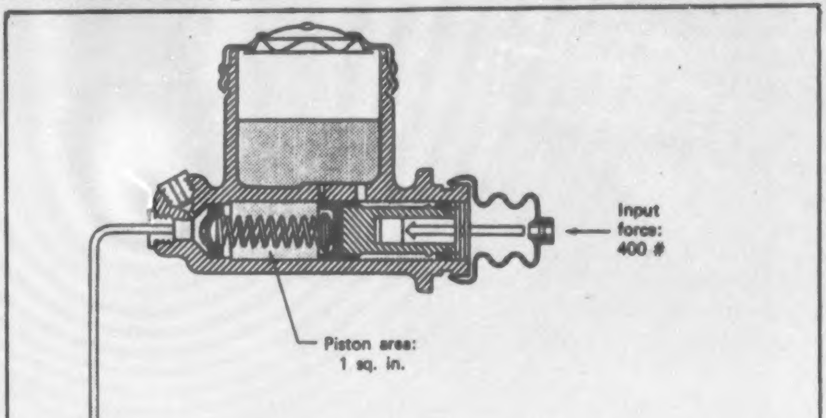

Rear Brake
Front Brake
FORWARD - REVERSE
TWO FORWARD SHOES

Centre Plane Brakes

Hydraulic System

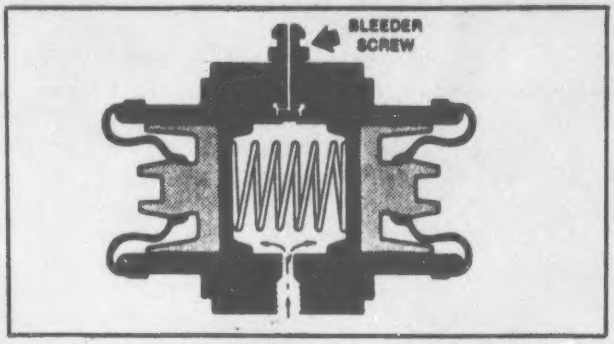
The hydraulic system controls the braking operation of a car and consists mainly of a master cylinder, hydraulic lines and hoses, the valving mechanism and the caliper or wheel cylinder. When the brake pedal is depressed, the master cylinder forces brake fluid to the wheel cylinders, via lines and hoses. Sliding rubber seals contain the fluid and prevent leakage.

Return springs in the master cylinder help the pedal return to its original unapplied position. Check valves regulate the flow of fluid in the master cylinder. There are several other valves such as the metering valve, proportioning valve, or combination valve that regulate the flow of the fluid to achieve efficient braking.


Input force: 400 #
Piston area: 1 sq. in.
Output force: 500 #
Output force: 500 #
Piston area: 1.25 sq. in.
Piston area: 0.75 sq. in.
Output force: 300 #
Output force: 300 #

Output forces in a typical hydraulic brake system.

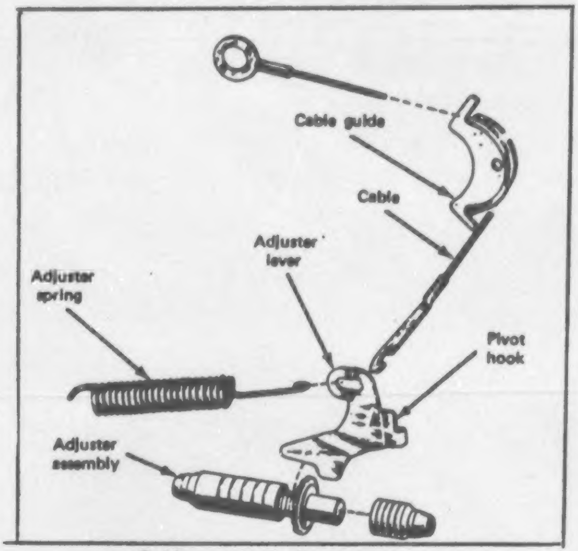
Since gas entrapped in the system compresses greatly at working pressures, it would lengthen the amount of pedal stroke required to apply the brakes and cause the pedal to feel "spongy" instead of firm. Any air bubbles will, therefore, have to be removed from the system. The servicing operation of removing the entrapped air from the brake system is called "bleeding". For this purpose, "bleeder screws", as shown, are provided in the cylinders.



Bleeder Screw Location

Automatic Adjusting Systems

The figure below shows a typical automatic adjusting system. Adjusters, whether cable, crank or lever systems, are installed on one shoe and operate when the shoe moves away from its anchor. The system upper link, or cable eye, is attached to the anchor. As the shoe moves, the cable system pulls over a guide mounted on the shoe web--the crank or lever systems pivot on the shoe web--and operates a lever-pawl which is attached on the shoe so that it engages a star wheel tooth. The pawl is located on the outer side of the star wheel and, on different styles, slightly above or



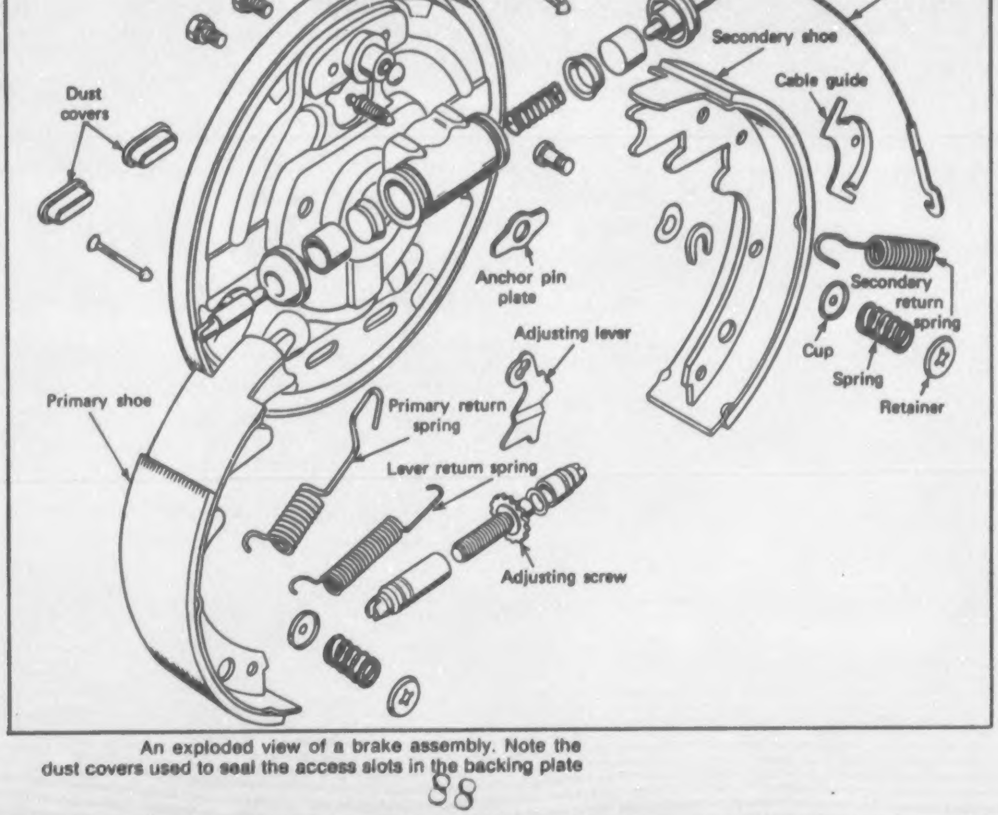
Cable-type self-adjuster parts

below the wheel center-line so that it serves as a ratchet lock which prevents the adjustment from backing off. However, whenever lining wears enough to permit sufficient shoe movement, the application pulls the pawl far enough off center to engage the next tooth. As the brake is released, the adjuster spring returns the pawl, thus advancing the star wheel one notch.

On most vehicles the adjuster system is installed on the secondary shoe, and thus operates as the vehicle is backing up. On few models it is located on the primary shoe, and operates as the vehicle moves forward. Left hand and right hand threaded star wheels are used on opposite brakes, therefore parts should be kept separated. If the wrong star wheel thread is installed, the system will backoff rather than tighten the adjustment.

Parts Nomenclature

A typical drum brake includes a backing or support plate with two lined brake shoes attached to it. shoe return springs and hold-down parts, a means of adjusting the shoes to compensate for the lining wear, and a drum. The drum brakes on the rear of most vehicles normally include the additional parts required for parking brakes. All of the drum brakes used on modern vehicles are of two general designs--duo-servo (or simply "servo"), and non-servo. Shoes and linings form an important part of any drum brake system and, therefore, servicing and installation of shoes and linings is very important to anybody involved in drum brake service.


Rod
Adjusting cable
Secondary shoe
Cable guide
Dust covers
Anchor pin plate
Secondary return spring
Cup
Spring
Retainer
Adjusting lever
Primary shoe
Primary return spring
Lever return spring
Adjusting screw

An exploded view of a brake assembly. Note the dust covers used to seal the access slots in the backing plate

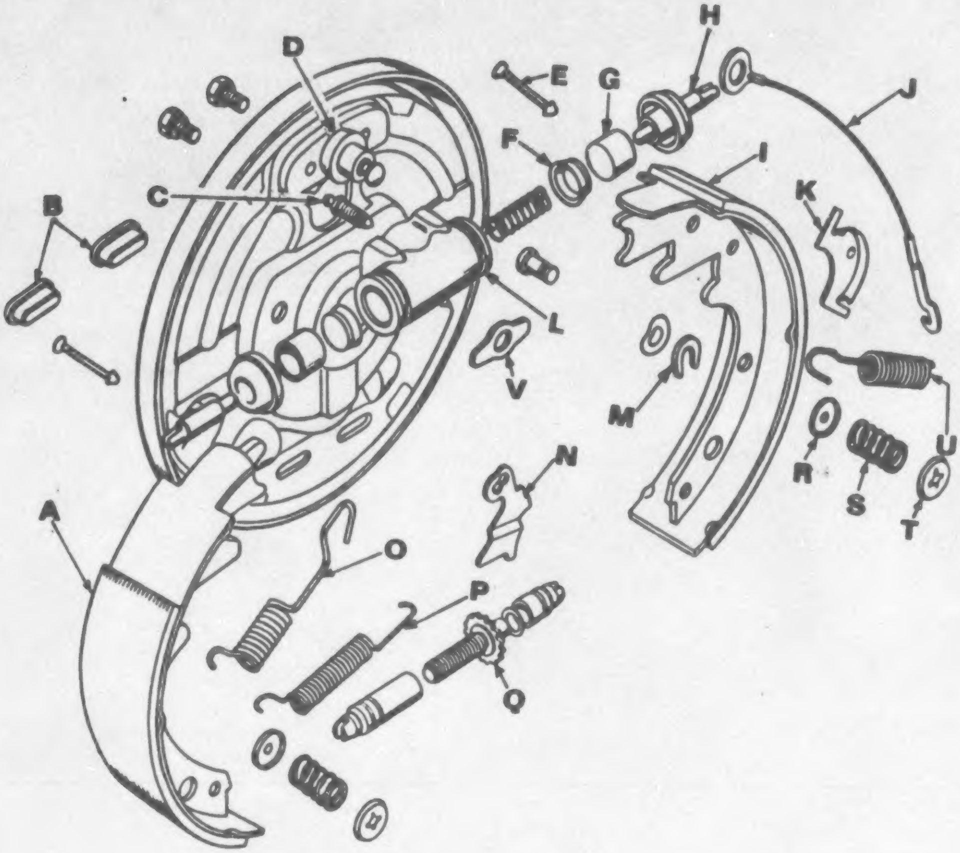
Brakes - Drum Brakes

No. C-3 Drum Brake Design

Worksheet # 1

Name ______________________________ **Date** ______________ **Grade** ________

Directions: In the lettered spaces below, identify the corresponding lettered part in the diagram.



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Auto Mechanics
Brake Parts - Inspection and Service

No. C-4

OBJECTIVE: Upon completion of this unit the student will be able to inspect and service individual drum brake components, at a level producing safe operating conditions.

EXPLANATION: This unit will involve the inspection of commonly serviced drum brake parts and the service of them.

MATERIALS NEEDED: Safety glasses

TOOLS NEEDED:

References	Do
#1. Chapter 1 pp. 21	1. Read assigned references.
#2. Chapter 18	2. Read information sheets.
#3. 517-518, 532-534	3. Check with instructor.
#4. Chapter 27 pp. 437-441	
#5. Chapter 41 pp. 441-446	
#6. Chapter 41 pp. 574-578	
#7.	
#8.	

WHEEL CYLINDERS

WHEEL CYLINDERS - Description

Wheel cylinders convert hydraulic pressure supplied by the master cylinder into a mechanical force at the wheel brakes.

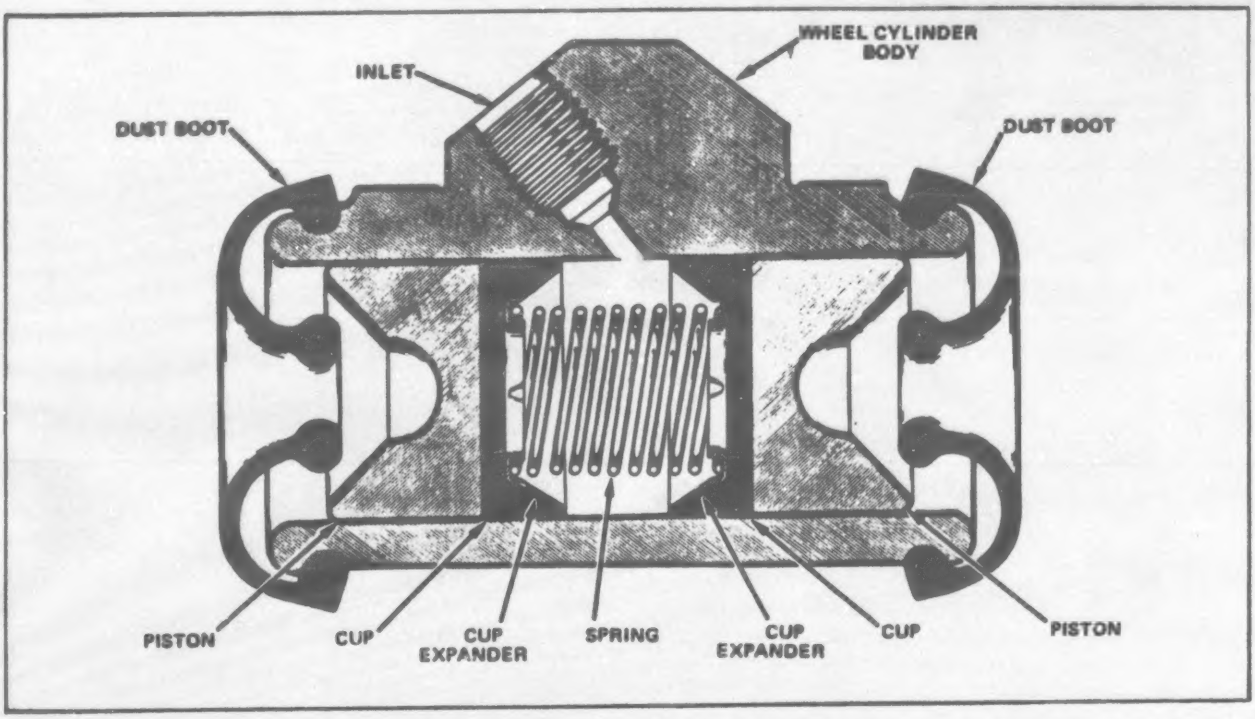
The three types of wheel cylinders that are used with drum brakes are...

.. Double Piston Straight Bore,
.. Double Piston Step Bore, and
.. Single Piston.

Double Piston Straight Bore

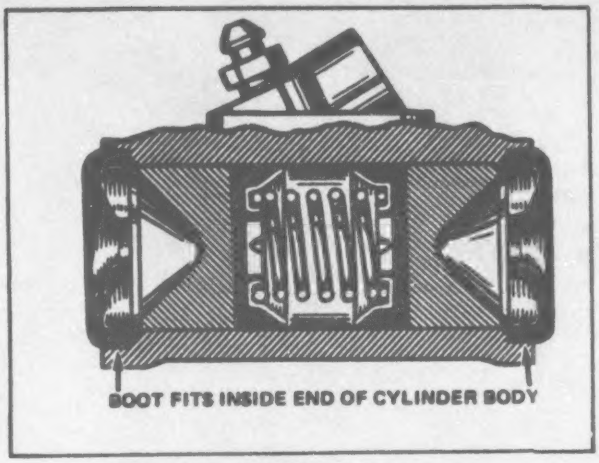
The double piston, straight bore wheel cylinder is the type most commonly used on modern automobile brakes.

A cross section of a typical double piston straight bore cylinder is shown below. All of the components of a typical cylinder are shown except a bleeder screw which is not illustrated.

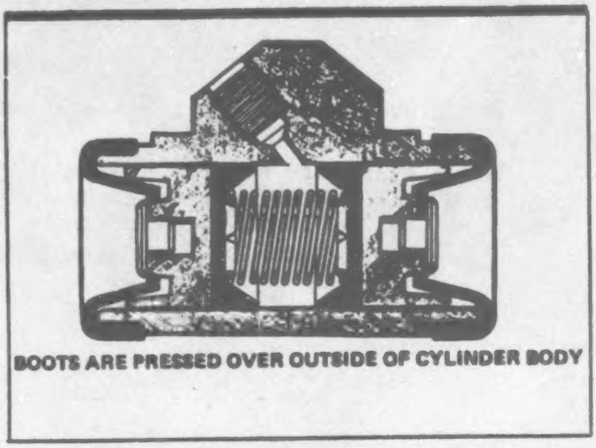

WHEEL CYLINDER BODY
INLET
DUST BOOT
DUST BOOT
PISTON
CUP
CUP EXPANDER
SPRING
CUP EXPANDER
CUP
PISTON

Cross Section of Typical Wheel Cylinder

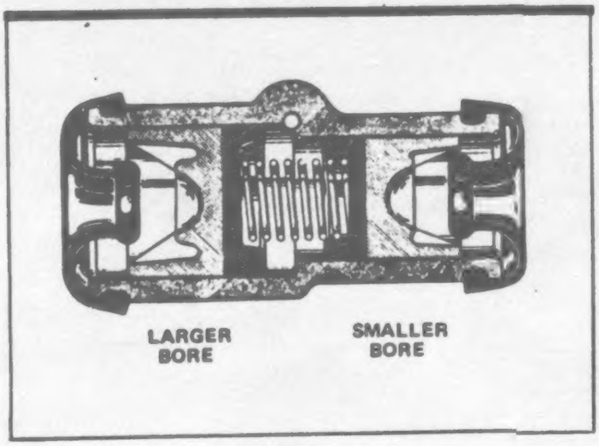
The figures below also show double piston straight bore cylinders but with varations in the method of attaching the dust boots to the cylinder body.


BOOT FITS INSIDE END OF CYLINDER BODY

Wheel Cylinder With Internal Boots


BOOTS ARE PRESSED OVER OUTSIDE OF CYLINDER BODY

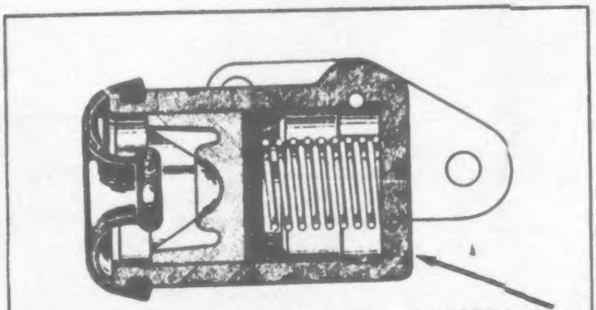
Wheel Cylinder With External Press-On Boots


LARGER BORE
SMALLER BORE

Step Bore Wheel Cylinder

Double Piston Step Bore

The double piston step bore wheel cylinder has the same components as the straight bore cylinder.
Two different sized dust boots, cups and pistons are used as shown at left to accomodate the two different sized cylinder bores.

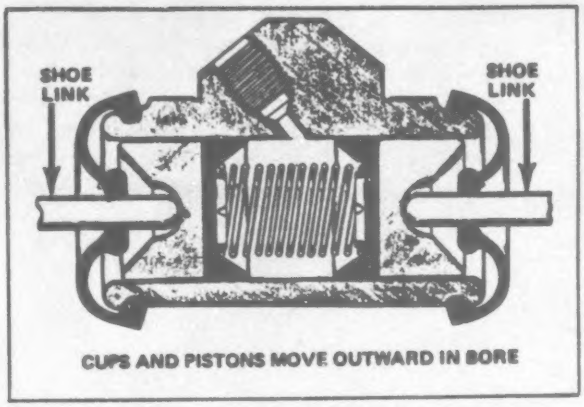

WHEEL CYLINDER BODY

Single Piston Wheel Cylinder

Single Piston

A single piston wheel cylinder has only one cup piston and dust boot as shown.

WHEEL CYLINDER SERVICE



Wheel Cylinder in Applied Position

Operation

The space in the cylinder bore between the cups must remain filled with fluid at all times. When the brake pedal is depressed, additional brake fluid is forced into the cylinder bore.

The additional fluid, which is under pressure, moves the cups and pistons outward in the bore. This, of course, moves the shoe links and brake shoes outward to contact the drum and apply the brakes.

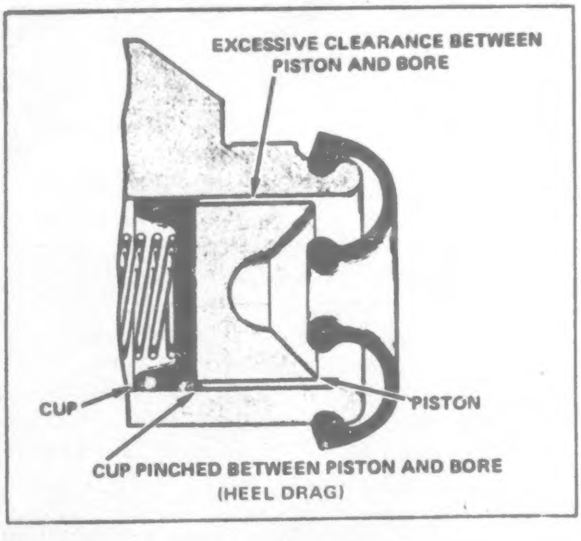
NOTE: On some brakes, the end of the shoe web bears directly against the pistons, and shoe links are not used.

Service

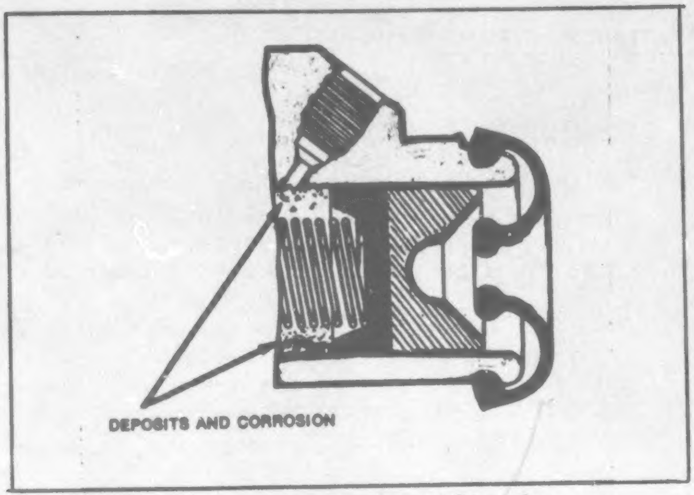
Wheel cylinders should be re-built or replaced whenever the brake shoes are replaced or more often when required to correct a leaking cylinder.

Diagnostic Inspection and Cleaning

Leaks which coat the boot and the cylinder with fluid, or result in a dropped reservoir fluid level, or dampen and stain the brake linings are dangerous. Such leaks can cause the brakes to "grab" or fail and should be immediately corrected. A leakage, not immediately apparent, can be detected by pulling back the cylinder boot. A small amount of fluid seepage dampening the interior of the boot is normal; a dripping boot is not. Unless other conditions causing a brake to pull, grab, or drag becomes obvious, the wheel cylinder is a suspect and should be included in general reconditioning.

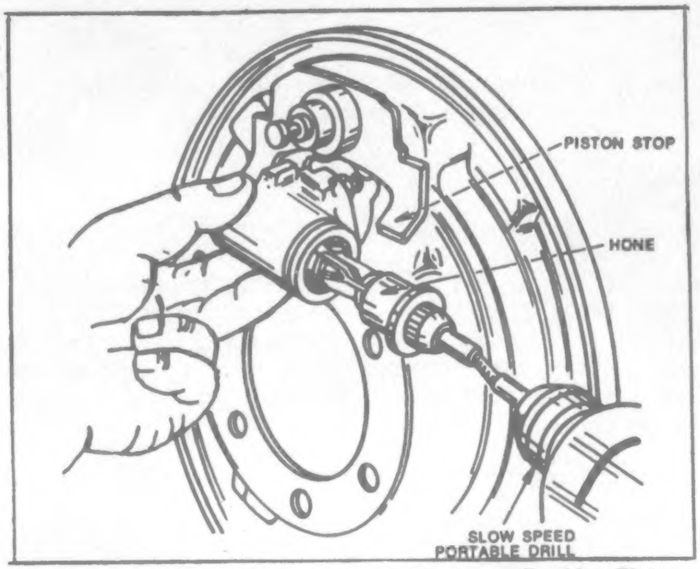

EXCESSIVE CLEARANCE BETWEEN PISTON AND BORE
CUP
PISTON
CUP PINCHED BETWEEN PISTON AND BORE
(HEEL DRAG)

Cylinder binding may be caused by rust, deposits, grime, or swollen cups due to fluid contamination, or by a cup wedged into an excessive piston clearance by pressure. If the clearance between the pistons and the bore wall exceeds the values on page 6, a condition called "heel drag" may exist. It can result in rapid cup wear and can cause the pistons to retract very slowly when the brakes are released.



Deposits and Corrosion
in Cylinder Bore

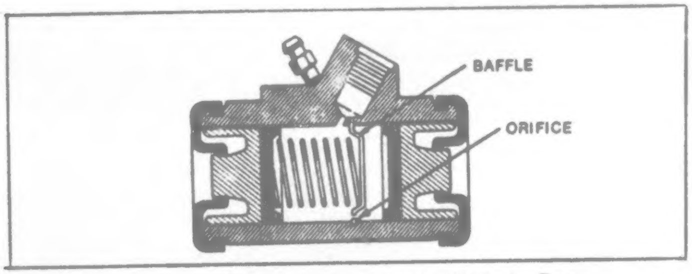
Whenever a wheel cylinder is disassembled, always inspect the cylinder bore for scoring, pitting and corrosion. A hard, crystal-like substance sometimes forms a ring in the cylinder bore near where the piston stops when the brakes are released.



Honing Wheel Cylinder on Backing Plate

Light roughness or deposits can be removed by means of a crocus cloth or an approved cylinder hone. While honing lightly, brake fluid can be used as a lubricant. If the bore cannot be cleaned up readily, the cylinder must be replaced.

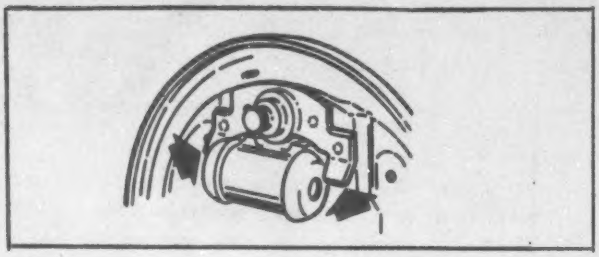
CAUTION--Hydraulic system parts should not be allowed to come in contact with oil or grease, neither should those be handled with greasy hands. Even a trace of grease or oil is sufficient to cause damage to the rubber parts.



Wheel Cylinder with Baffle in Bore

Some front wheel cylinders have a baffle located between the opposed pistons. The baffle contains a small hole which causes the cylinder to act as a fluid shock absorber in order to dampen servo br[illegible] shoes as they become energized. These cylinders cannot be honed and should be replaced if the bore is pitted or corroded.

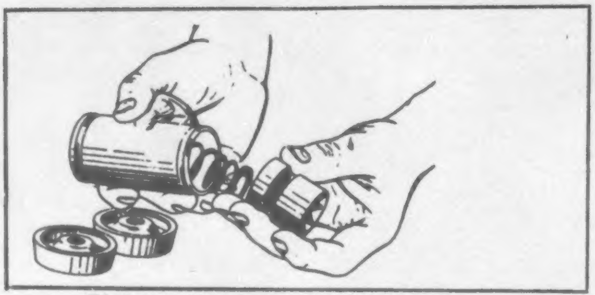
Reconditioning Drum Brake Wheel Cylinders



Typical Piston Stops

NOTE: Before attempting to rebuild any wheel cylinder, make sure that the bleeder screw can be loosened. A frozen or broken bleeder screw may result in the replacement of the entire wheel cylinder assembly.

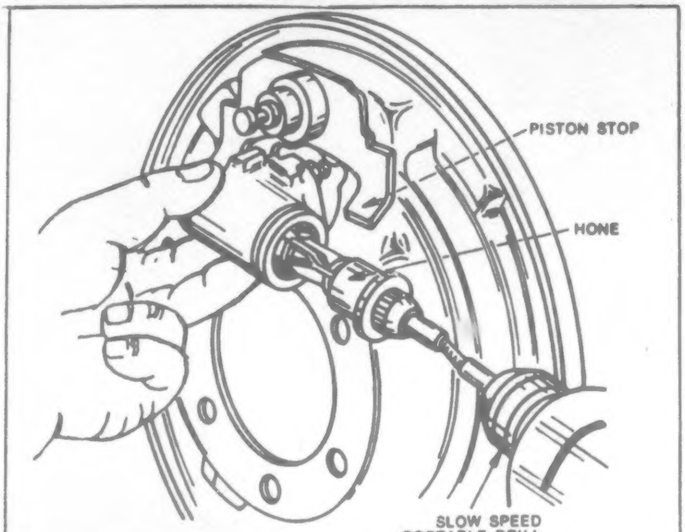
It is a common practice to recondition a drum brake wheel cylinder without dismounting it, however some brakes are equipped with external piston stops which prevent disassembly unless the cylinder is removed. In order to dismount, remove the shoe springs and spread the shoes apart, disconnect the brake line, remove the mounting bolts and pull the cylinder free.

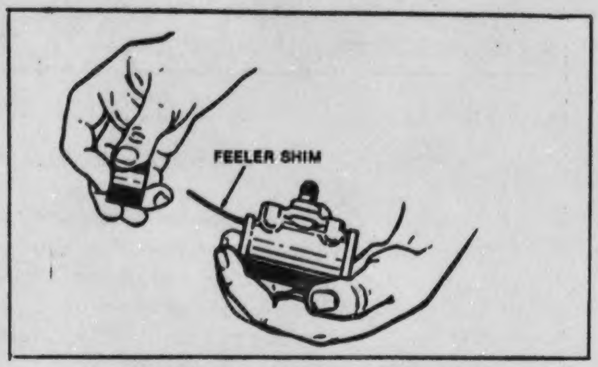


Disassembly of the Wheel Cylinder

Pull the protective dust boots off the cylinder. Internal parts should slide out, or be picked out easily. Parts can be driven out with a wooden dowel, or blown out at low pressure by applying compressed air to the fluid inlet port. Parts which cannot be removed easily indicate damage too extensive for usual cylinder reconditioning

Clean the cylinder and the parts in alcohol and/or brake fluid. (Do NOT use gasoline.) Use only lint-free wiping cloths. Crocus cloth can be used to clean minute scratches, signs of rust, corrosion or discoloration from the cylinder bore and pistons. Slide the cloth in a circular rather than a lengthwise motion. A clean-up hone may be used. When a cylinder has been honed, inspect it for excessive piston clearance and remove any burr formed on the edge of dluid intake or the bleeder screw ports.



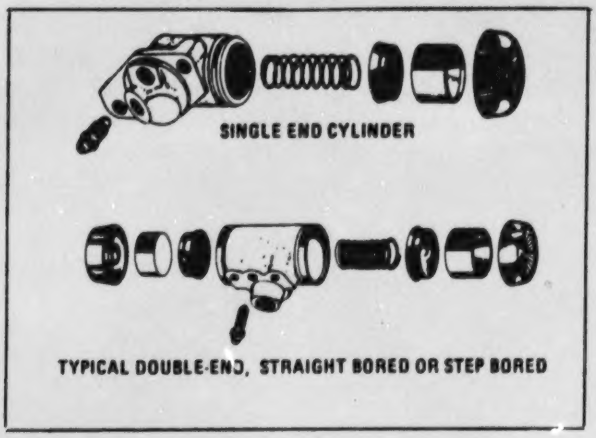


Checking the Maximum Piston Clearance

To check the maximum piston clearance, place a 1/4" (6 mm) wide strip of feeler shim lengthwise in the cylinder bore as shown at left. (See thickness chart.)

If the piston can be inserted with the shim in place, the cylinder is oversize, and should be discarded. Depending upon the cylinder bore diameter, the shim (or the feeler gauge) thickness can vary as follows:

Cylinder bore I.D.	3/4"-1 3/16" (19-30 mm)	1¼"-1 7/16" (32-37 mm)	1½" and up (38 mm & [illegible])
Shim (Feeler Gauge)	0.006" (0.15 mm)	0.007" (0.18 mm)	0.008" (0.20 mm)



Wheel Cylinder Components

Assemble the cylinder with the internal parts, making sure that the cylinder wall is wet with brake fluid. Insert the cups and pistons from each end of a double-end cylinder; do not slide them through the cylinder. Cup lips should always face inward.

Service G.M. "A" and "X" Body Wheel Cylinders

G. M. X-Body wheel cylinders are not bolted to the backing plate in a conventional manner, but use a retaining clip. The following material details removal and installation procedure.

3. REMOVE AND INSTALL WHEEL CYLINDER.

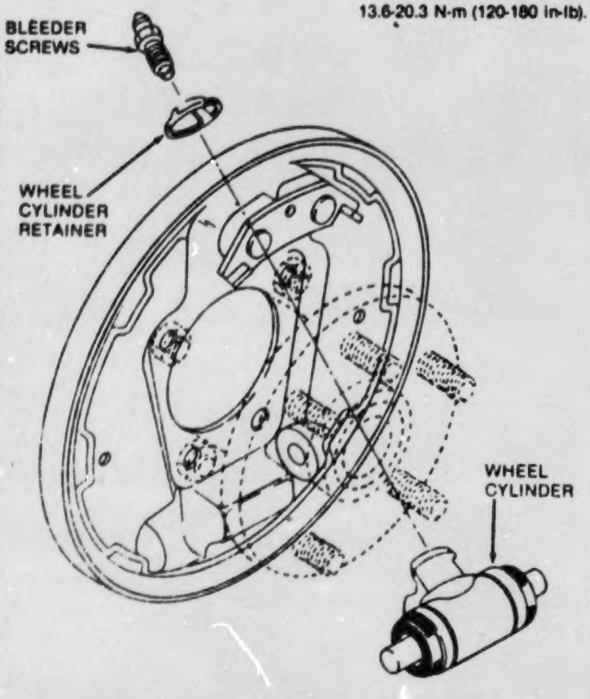
REMOVE

1. Remove dirt and foreign material around wheel cylinder inlet and pilot.
2. Disconnect inlet tube line.
3. Remove parts as shown in A following.

INSTALL

SEE NOTICE ON PAGE 5-1 OF THIS SECTION.

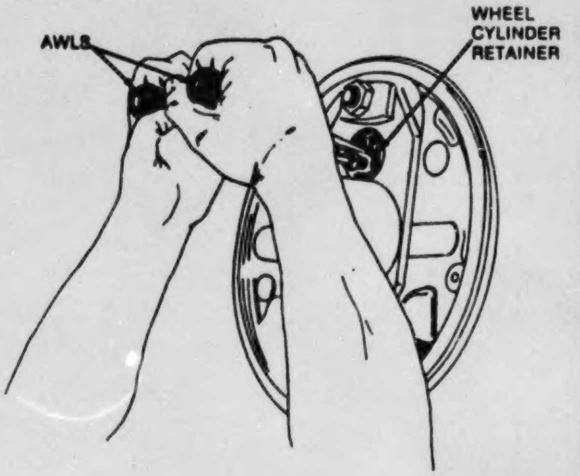
1. Install parts as shown in B following.
2. Torque bleeder screw to 3.4-7.9 N-m (30-70 in-lb).
3. Torque inlet tube nut to 13.6-20.3 N-m (120-180 in-lb).


BLEEDER SCREWS
WHEEL CYLINDER RETAINER
WHEEL CYLINDER

A.

REMOVE

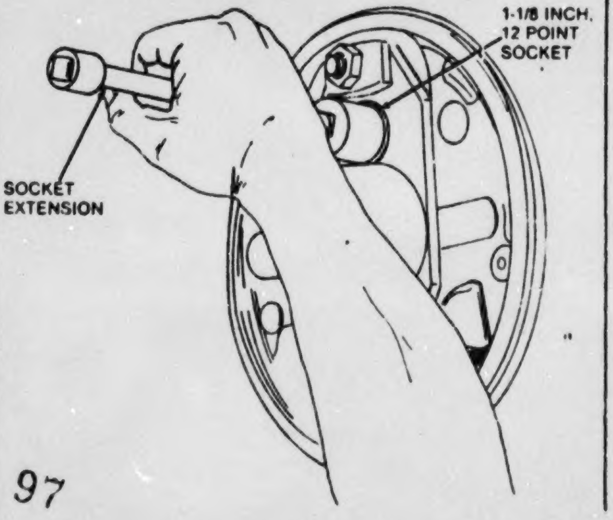
1. Remove wheel cylinder retainer using two awls or pins (1/8 inch diameter or less).
2. Insert awls or pins into access slots between wheel cylinder pilot and retainer locking tabs.
3. Bend both tabs away simultaneously.


AWLS
WHEEL CYLINDER RETAINER

B.

INSTALL

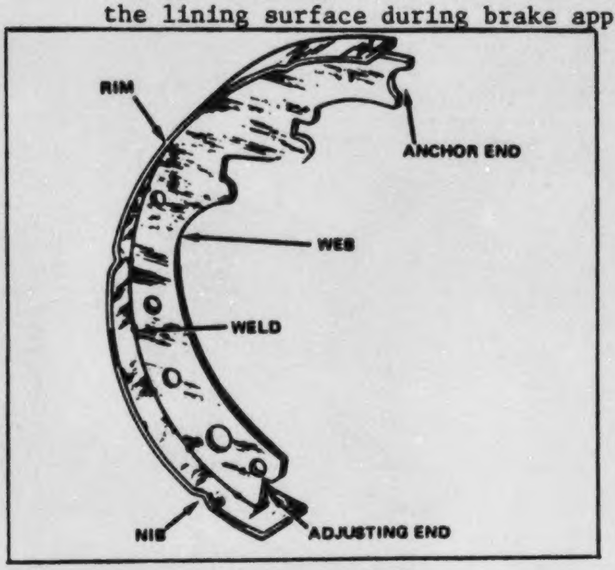
1. Position wheel cylinder and hold in place with wooden block between cylinder and axle flange.
2. Install new retainer over wheel cylinder abutment as shown using a 1-1/8 inch, 12 point socket and socket extension.


1-1/8 INCH, 12 POINT SOCKET
SOCKET EXTENSION

BRAKE SHOES AND LININGS

BRAKE SHOES - Description

The brake shoe is the backbone of a drum brake. The shoe must support the lining and carry it into the drum so that the pressure is distributed across the lining surface during brake applications.

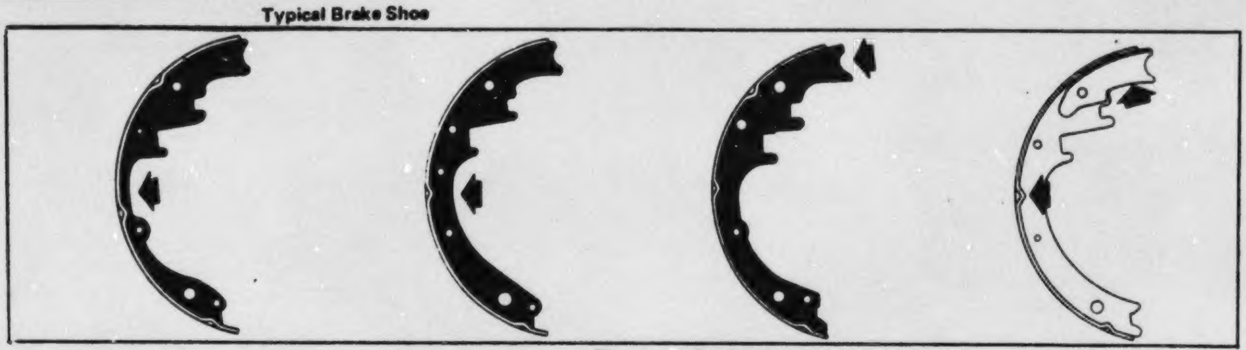


Typical Brake Shoe

A typical brake shoe is shown. Individual shoes may vary in size and appearance, but many points are common to all shoes.

The shoe rim is welded to the web to provide a table surface for the lining. The web thickness may vary to provide the stiffness or flexibility needed for a specific application.

Many shoes have nibs or indented places along the edge of the rim. These nibs rest against shoe support ledges on the backing plate and keep the shoe from hanging up.

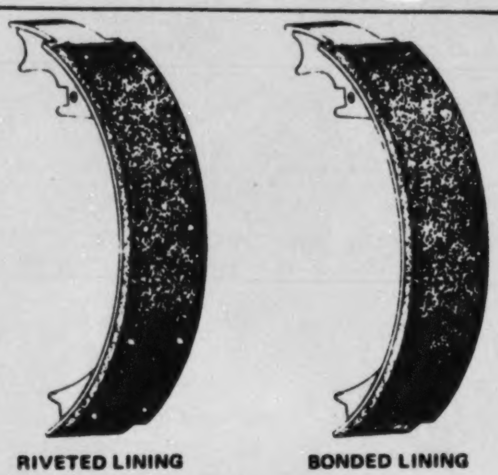


Types of Brake Shoes

BRAKE LININGS

Another important component of the wheel brake is the lining which provides the friction against the drum to stop the car.

There are many different linings depending both on the ingredients used in making the lining and the method of manufacture.


RIVETED LINING
BONDED LINING

Lining Attachment

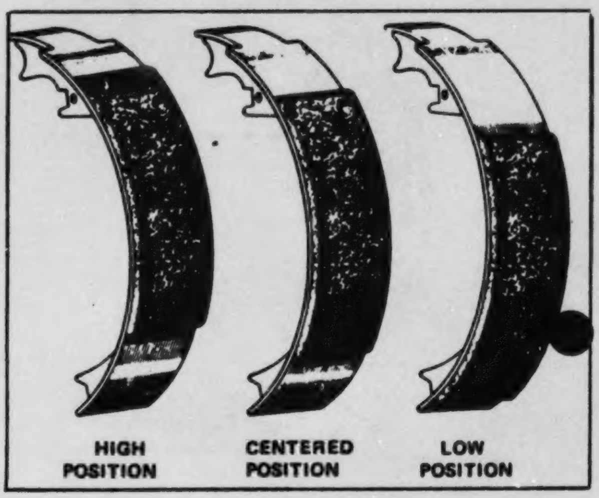
Lining Attachment

The two general methods of attaching the lining to the shoe are riveting and bonding.

Lining Position

The location of the lining on the shoe is also important. The secondary shoe normally has a full length lining that is centered on the shoe.

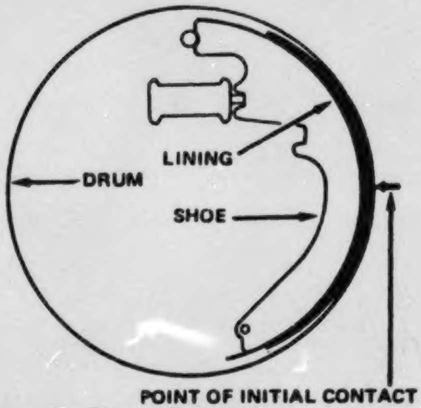
The primary shoe, however, has a shorter length of lining that may be in a high, centered or low position of the shoe as shown at right. The position of the lining affects the servo action of the brake.


HIGH POSITION
CENTERED POSITION
LOW POSITION

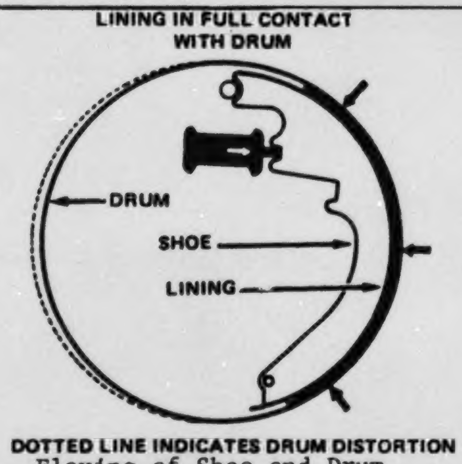
Lining Position

Lining to Drum Contact

Most brake linings used today are ground so that they are slightly thicker at the center. Thus when the brakes are applied and the shoes and linings move outward to the drum, the center of the lining contacts the drum first as shown below left. There is a slight clearance between the drum and lining at each end of the lining. As the brake pressure is increased, both the shoe and the drum flex slightly to bring the entire lining surface into contact with the drum as shown below right.


LINING
DRUM
SHOE
POINT OF INITIAL CONTACT

Lining to Drum Contact

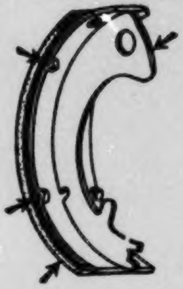

LINING IN FULL CONTACT WITH DRUM
DRUM
SHOE
LINING
DOTTED LINE INDICATES DRUM DISTORTION

Flexing of Shoe and Drum

BRAKE SHOE AND LINING SERVICE

Relining Shoes

In the past, brake shoe service included actual lining replacement by riveting onto the original shoe. With the advent of bonded linings, however, replacement methods advanced beyond the capabilities of most service shops. As a result, today's service on brake linings involves simply the replacement of the shoe/lining assembly with a new or factory relined shoe. Shoe replacement is necessary when linings have worn to 1/32" thick at any place on the shoe, or to within 1/64" from rivet heads on riveted linings.



Dress Down Lining Overhang, Shoe Table Edge and Shoe Web

Before installing the shoes, sand or stone the inner edge of the shoe to dress down any slight lining overhang or metal nicks and burrs which could interfere with the sliding fit upon the support pads.

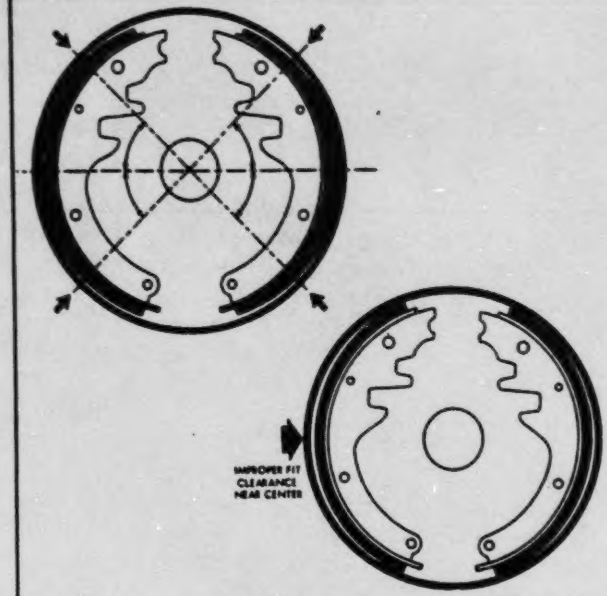
Replacement Shoe to Drum Fit

A very important final check during shoe replacement is to gauge the shoe fit against the brake drum surface.

To operate properly, brake shoes must have a contoured size which is slightly less in diameter than the drum size. "Arc", "Cam", "Offset", and "Eccentric" grind are all popular terms used to describe the contoured brake shoe.

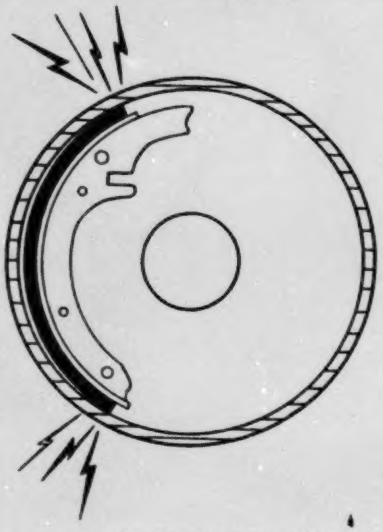
A properly arc ground shoe will:

a. provide a slight flexing of the shoe to give smooth and quiet operation,
b. allow for slight misalignment of shoe anchor parts, and
c. create favorable conditions for proper break in.



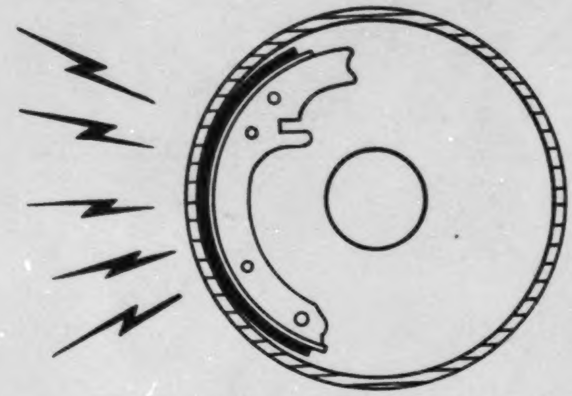
Check the Fit of the Lined Shoes in the Drum

To check the fit of the lined shoes in drum, place the contour ground shoes opposite each other with the arc centers touching the drum surface. Some lining to drum clearance should exist at both the toe and the heel of each shoe. This clearance should be about 0.010" at both ends when checked with a feeler gauge.



Oversize lining installed in a near-standard drum
(courtesy AMMCO TOOLS, Inc.)

CAUTION: Never install a lined shoe if the lining clearance appears near the center of the arc instead of the ends. This is an improper grind which would allow lining ends to pinch and result in squeal, grab, pull, or cause the brake to lock.



Standard lining installed in an oversize drum
(courtesy AMMCO TOOLS, Inc.)

When excessive clearance (0.020" or more) exists, this would result in initial contact at the middle of the lining. But, the lining in the middle of the shoe would be doing all the work and would be subjected to extreme temperatures and severe wear. In addition, the pedal would feel spongy because the shoe would flex, or bend, excessively. The lining at the center of the shoe would eventually wear enough so that more lining surface would contact the drum. But until then, the brakes would not feel or function properly. It is important to always achieve a proper shoe fit.

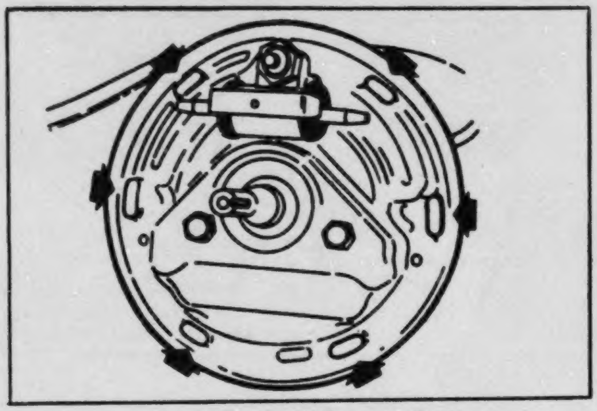
New or relined shoes are generally contour ground to fit drum sizes of standard to 0.030" oversize. If the brake drum has been remachined to a size greater than 0.030" over standard, an oversize lining with the proper contour may be available. If not, the standard lining should be "arc ground" to achieve the proper fit using special equipment for this purpose.

The contour or arc grinding process will be covered in more detail under brake drum remachining.

BRAKE HARDWARE

SUPPORT (BACKING) PLATES

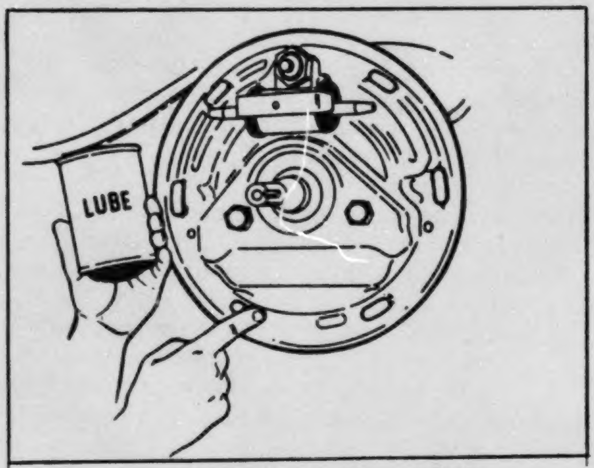
Backing plates provide for both the support and guiding of brake shoes. They may also provide attachment points for the shoe anchor and wheel cylinder while shielding the brake assembly from dust and water.



Dress All Support Pads

BACKING PLATE SERVICE

Support (backing) plates must be tight on its mount and not bent. Stone the shoe support pads bright and dress down any burrs or grooves which could cause shoes to hang up. Deeply grooved backing plates may require welding repair or backing plate replacement.

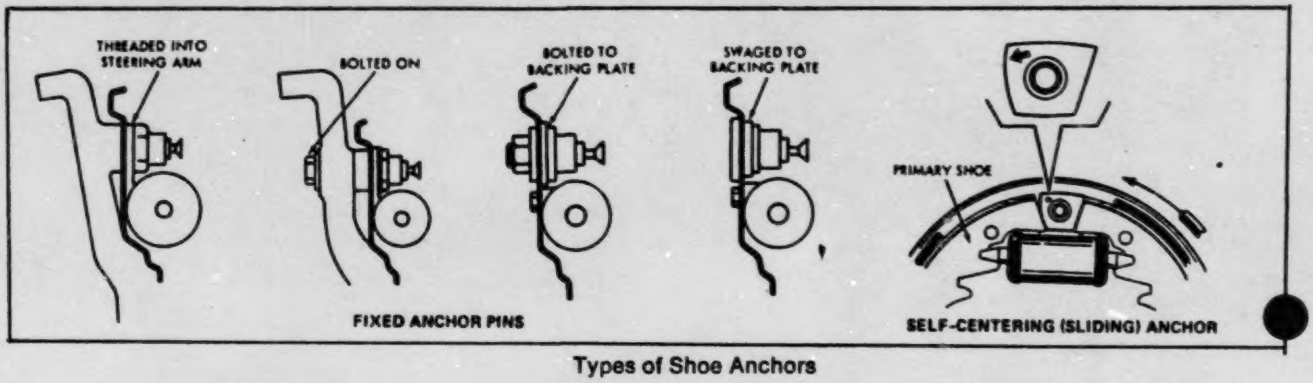


Lubricating the Support Pads

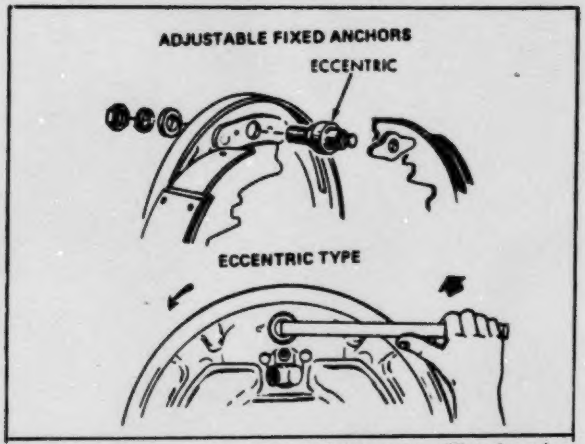
Using a molylube or molybedenum grease, LIGHTLY coat the support pads.

SHOE ANCHORS

As shown below, shoe anchors are of various types such as the fixed non-adjustable type, or self-centering shoe sliding type, or, on some earlier models, adjustable fixed type providing either an eccentric or a slotted adjustment. On some front brakes, fixed anchors are threaded into or are bolted through the steering knuckle and also support the wheel cylinder.


THREADED INTO STEERING ARM
BOLTED ON
BOLTED TO BACKING PLATE
SWAGED TO BACKING PLATE
PRIMARY SHOE
FIXED ANCHOR PINS
SELF-CENTERING (SLIDING) ANCHOR

Types of Shoe Anchors

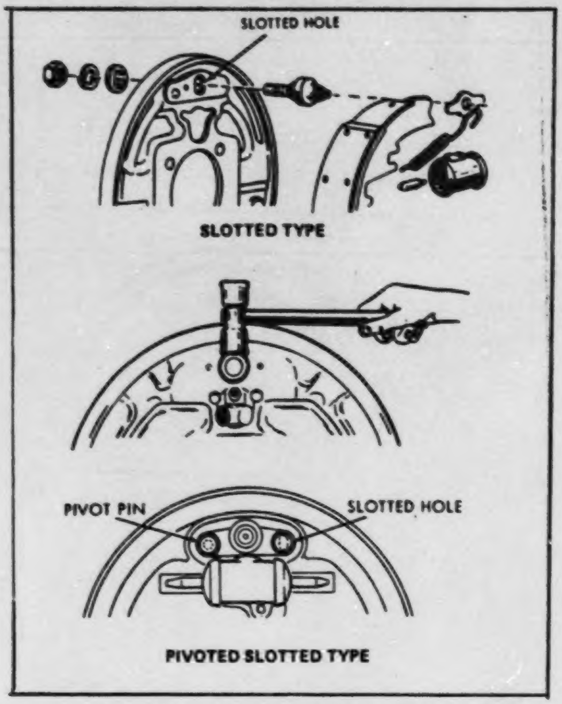

ADJUSTABLE FIXED ANCHORS
ECCENTRIC
ECCENTRIC TYPE

Anchor Adjustment—Fixed and Eccentric

SHOE ANCHOR SERVICE

On the adjustable anchors, when necessary to re-center the shoes in the drum or the drum gauge, loosen the locknut enough to permit the anchor to slip but not so much that it can tilt.

On the eccentric type anchors, tighten the star wheel to heavy brake drag. Rotate the eccentric anchor in the direction which frees the brake until drag is again encountered. Return the eccentric to the free center between the two points of drag. Repeat this sequence until drag cannot be relieved. Tighten the anchor nut. Back off the star wheel to a normal manual adjustment.


SLOTTED HOLE
SLOTTED TYPE
PIVOT PIN
SLOTTED HOLE
PIVOTED SLOTTED TYPE

Anchor Adjustment—Slotted Type

On the slotted type anchor, tighten the star wheel to heavy drag. Tap the support plate until the anchor slips and frees the brake. Repeat this sequence until drag cannot be relieved. Tighten the locknut to 100-200 lb. ft. (136-162 N·m) torque. Back off the star wheel to a normal manual adjustment.

BRAKE SHOE RETURN SPRINGS

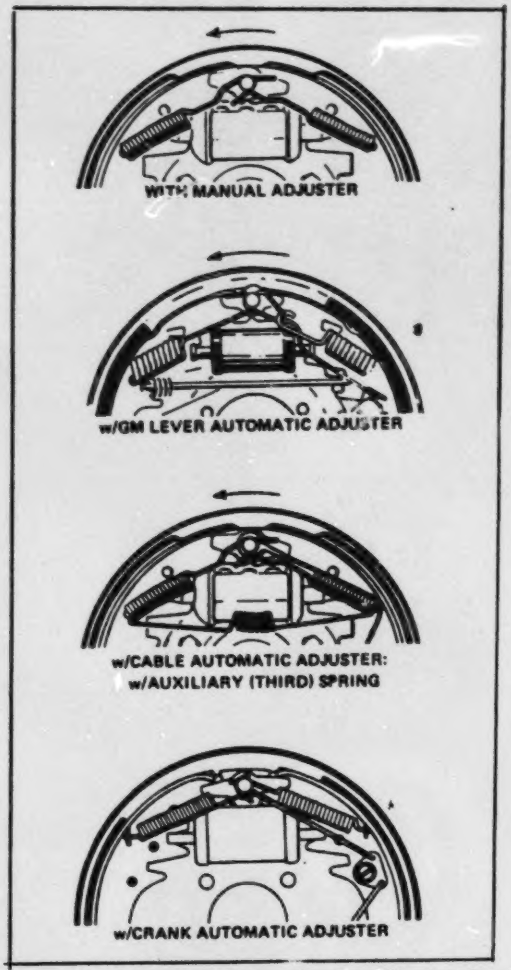
Return springs are usually color-coded. Various types of alignments are shown at the right. Springs are normally installed on the anchor next to the shoes in the order shown under each category listed below.

(A) Manual Adjusters: (1) Anchor plate (2) primary spring (3) secondary spring.

(B) GM Lever Adjusters: (1) Anchor plate (2) adjuster link (secondary spring hooks into the link loop) (3) primary spring.

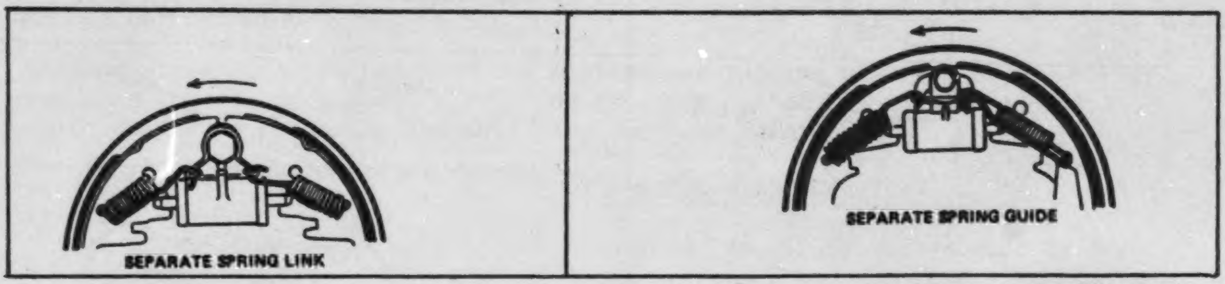
(C) Cable Adjusters: (1) Anchor plate (2) cable eye (3) primary spring (4) secondary spring. Auxiliary spring: When a helper (third) spring is attached between the shoes, it is hooked into the coiled ends of the primary and secondary springs.

(D) Crank Adjusters: On primary shoe-- (1) anchor plate (2) primary spring (3) secondary spring (4) adjuster link. On secondary shoe--(1) anchor plate (2) secondary spring (3) primary spring (4) adjuster link.


WITH MANUAL ADJUSTER
w/GM LEVER AUTOMATIC ADJUSTER
w/CABLE AUTOMATIC ADJUSTER: w/AUXILIARY (THIRD) SPRING
w/CRANK AUTOMATIC ADJUSTER

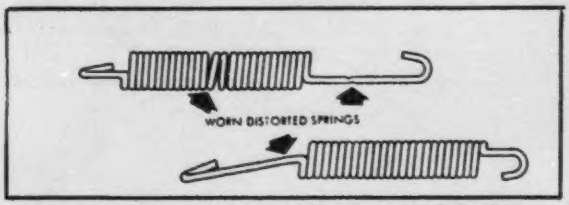
Shoe Return Spring Alignments

Springs may be separately hooked into a link or a guide, or between the shoes.



Shoe Return Spring Alignments

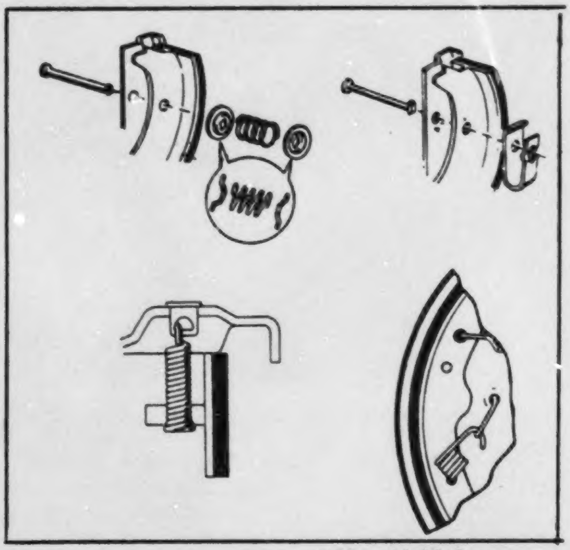
SHOE RETURN SPRING SERVICE



Inspect for Damaged Springs

Examine the shoe, anchor, support plate, and small parts for signs of looseness, wear or damage which could cause faulty shoe alignment. Check springs for spread or collapsed coils, twisted or nicked shanks and severe discoloration.

Replace defective parts.



Types of Shoe Hold-downs

BRAKE SHOE HOLD-DOWNS

To unlock or lock the straight pin hold-downs, depress the locking cup and coil spring, or the spring clip, and rotate the pin or lock 90 degrees. On GM lever type adjusters, the inner (bottom) cup has a sleeve which aligns the adjuster lever.

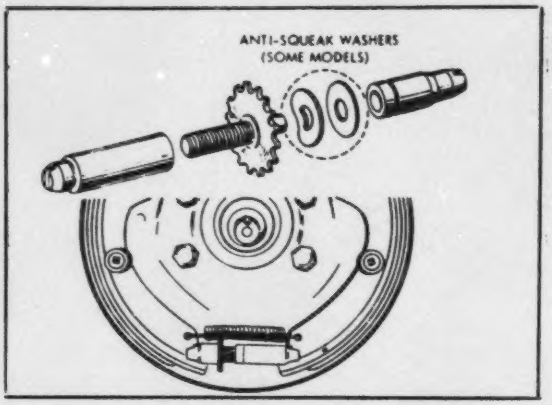
SHOE HOLD-DOWN SERVICE

Examine shoe hold-down mechanisms for corrosion or distortion. Replace defective parts.

STAR WHEEL ADJUSTER AND LINK SPRING

Opposite the anchor, a star wheel adjuster links the shoe webs and provides a threaded adjustment which permits the shoes to be expanded or contracted. The shoes are held against the adjuster by a spring which is hooked directly to both shoe webs. On some cable type automatic adjusters, the spring is connected between one shoe web and an adjuster lever-pawl mounted on the opposite shoe.

Manual Adjusters: The adjuster spring bears on the star wheel teeth, providing a ratchet lock. A slot in the support plate provides access for adjusting the star wheel. Star wheel adjusters usually have right-hand threads so that, on opposite brakes, they rotate in opposite directions to tighten or loosen. On many vehicles, however, the positions of opposite star wheels are reversed end-for-end on left and right brakes. This is usually indicated by a difference in the location of opposite access slots. Then, in relation to their access slots, the teeth of both star wheels are rotated in identical manner to make adjustments.



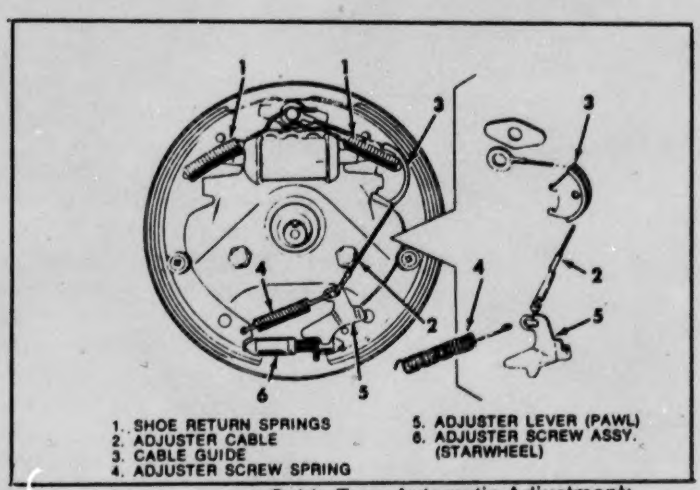
Typical Starwheel Adjustment

STAR WHEEL ADJUSTER SERVICE

Operate the starwheel type automatic adjuster by prying the shoe lightly away from its anchor or by pulling the cable to make sure the adjuster advances easily, one notch at a time. The adjuster cables tend to stretch, star wheels and pawls become blunted over a long period of use. These parts should be closely inspected for wear and damage. Using a molylube or molybdenum grease, LIGHTLY coat the support pads and the threads of servo type star wheel adjusters.

AUTOMATIC ADJUSTER MECHANISMS

The figure below shows a typical automatic adjusting system. Adjusters, whether cable, crank or lever systems, are installed on one shoe and operate when the shoe moves away from its anchor. The system upper link, or cable eye, is attached to the anchor. As the shoe moves, the cable system pulls over a guide mounted on the shoe web--the crank or lever systems pivot on the shoe web--and operates a lever-pawl which is attached on the shoe so that it engages a star wheel tooth. The pawl is located on the outer side of the star wheel and, on different styles, slightly above or below the wheel center-line so that it serves as a ratchet lock which prevents the adjustment from backing off. However, whenever lining wears enough to permit sufficient shoe movement, the application pulls the pawl far enough off center to engage the next tooth. As the brake is released, the adjuster spring returns the pawl, thus advancing the star wheel one notch.


1
1
3
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4
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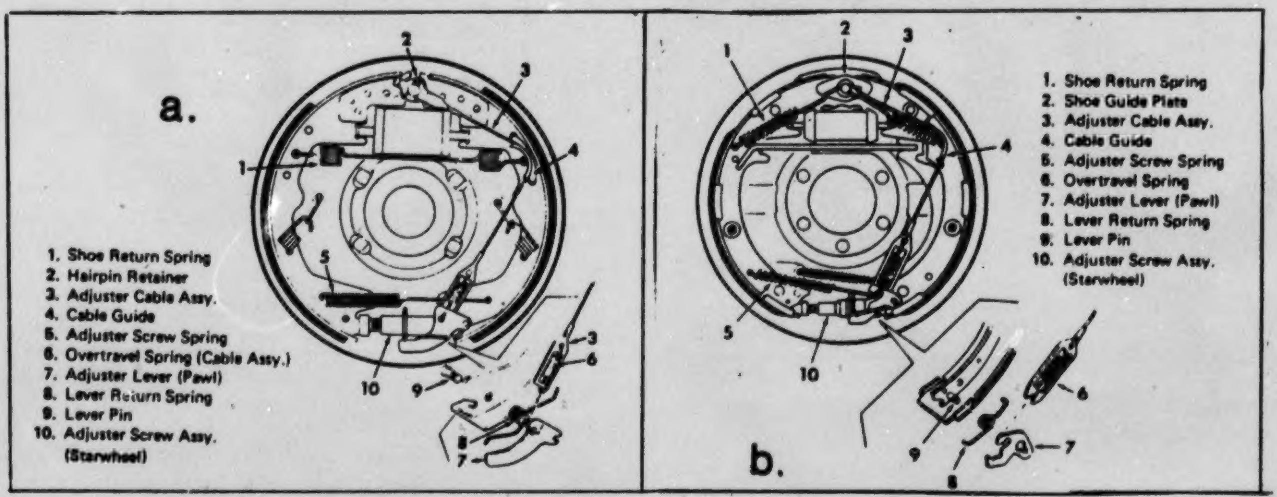
6
5
1. SHOE RETURN SPRINGS
2. ADJUSTER CABLE
3. CABLE GUIDE
4. ADJUSTER SCREW SPRING
5. ADJUSTER LEVER (PAWL)
6. ADJUSTER SCREW ASSY. (STARWHEEL)

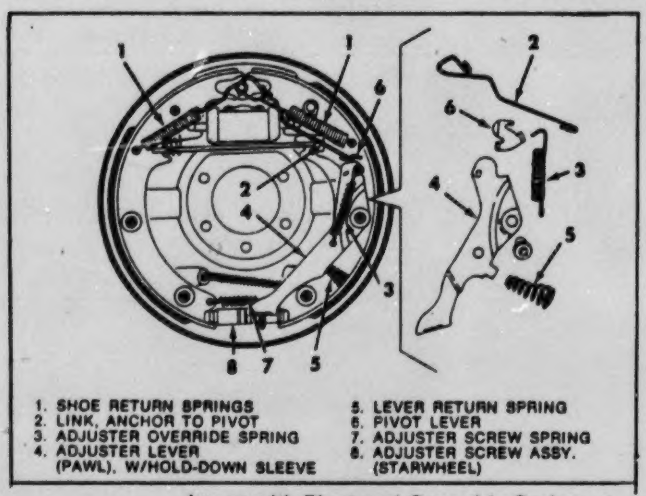
Cable Type Automatic Adjustment;
Ford, Chrysler, American (some), Rambler 8's
Left Front Shown

Figures "a" and "b" below show systems with an up-stroke pawl advance; the left brake with left hand threads, and the right brake with right hand threads.

The lever-pawl is installed on a web pin with an additional pawl return "mousetrap" spring. The cable is looked to the lever-pawl by means of an over-travel spring installed in the cable hook. The over-travel spring dampers movements and prevents unnecessary adjustment should sudden hard braking cause excessive drum deflection and shoe movement.


a.
1. Shoe Return Spring
2. Hairpin Retainer
3. Adjuster Cable Assy.
4. Cable Guide
5. Adjuster Screw Spring
6. Overtravel Spring (Cable Assy.)
7. Adjuster Lever (Pawl)
8. Lever Return Spring
9. Lever Pin
10. Adjuster Screw Assy. (Starwheel)
b.
1. Shoe Return Spring
2. Shoe Guide Plate
3. Adjuster Cable Assy.
4. Cable Guide
5. Adjuster Screw Spring
6. Overtravel Spring
7. Adjuster Lever (Pawl)
8. Lever Return Spring
9. Lever Pin
10. Adjuster Screw Assy. (Starwheel)

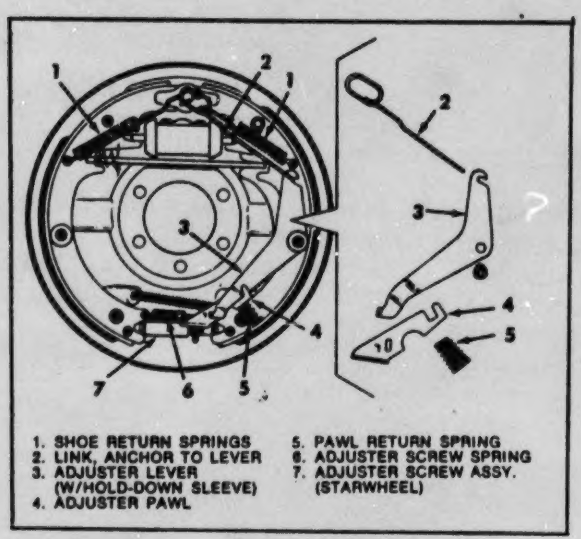
—Cable Type Automatic Adjustment with Overtravel Spring


1. SHOE RETURN SPRINGS
2. LINK, ANCHOR TO PIVOT
3. ADJUSTER OVERRIDE SPRING
4. ADJUSTER LEVER (PAWL), W/HOLD-DOWN SLEEVE
5. LEVER RETURN SPRING
6. PIVOT LEVER
7. ADJUSTER SCREW SPRING
8. ADJUSTER SCREW ASSY. (STARWHEEL)

Lever with Pivot and Over-ride Spring
General Motors Makes; Left Rear Shown

The system shown at left uses a down stroke pawl advance; the left brake with right hand threads, and the right brake with left hand threads.

The lever-pawl is mounted on a shoe hold-down, pivoting on a cup sleeve, and has a separate lever-pawl return spring located between the lever and the shoe table. A pilot lever and an over-ride spring assembled to the upper end of the main lever dampen action, prevent unnecessary adjustment in the event of excessive drum deflection.


1
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6
4
5
10
1. SHOE RETURN SPRINGS
2. LINK, ANCHOR TO LEVER
3. ADJUSTER LEVER (W/HOLD-DOWN SLEEVE)
4. ADJUSTER PAWL
5. PAWL RETURN SPRING
6. ADJUSTER SCREW SPRING
7. ADJUSTER SCREW ASSY. (STARWHEEL)

Lever and Pawl
General Motors Makes
Left Rear Shown

This figure at the right shows a system which uses a down-stroke pawl advance; the left brake with right hand threads and the right brake with left hand threads. The lever is mounted on a shoe hold-down, pivoting on a cup sleeve, and is engaged with the pawl. A separate pawl return spring is located between the pawl and the shoe.

AUTOMATIC ADJUSTER SERVICE

On most vehicles the adjuster system is installed on the secondary shoe, and thus operates as the vehicle is backing up. On few models it is located on the primary shoe, and operates as the vehicle moves forward. Left hand and right hand threaded star wheels are used on opposite brakes, therefore parts should be kept separated. If the wrong star wheel thread is installed, the system will backoff rather than tighten the adjustment.

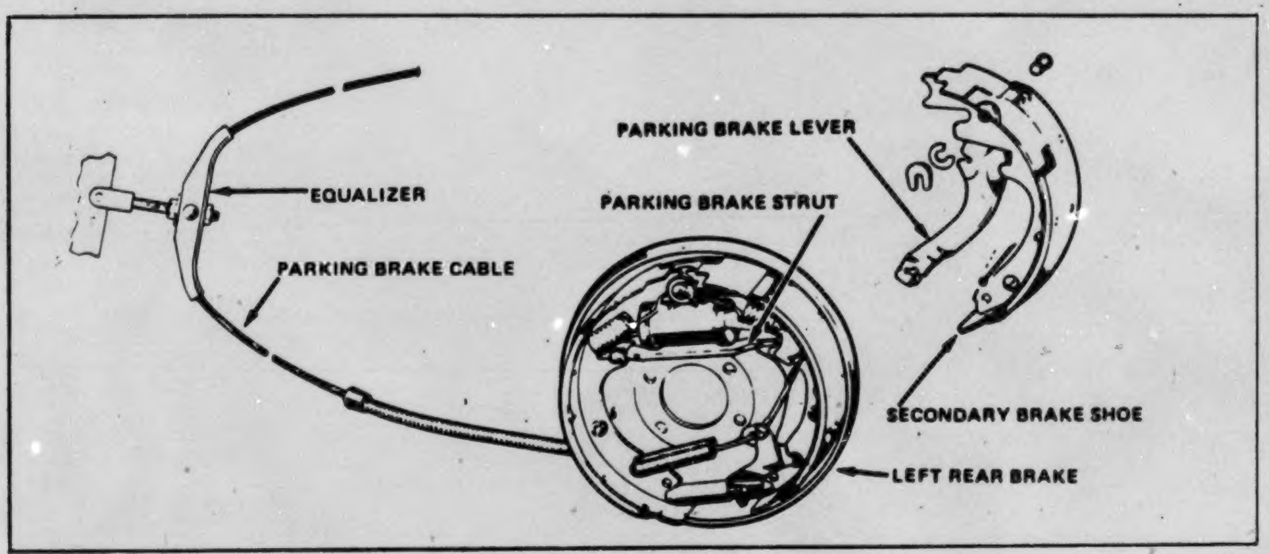
Carefully inspect all parts for wear and damage, replace as required.

CAUTION--IMPORTANT--Dual (safety) Brake Systems--Do not convert the automatic adjusters to manual type on brake systems equipped with a tandem master cylinder, since that would nullify the system safety feature.

INTEGRAL PARKING BRAKE HARDWARE

The integral parking brake was introduced along with the development of the Bendix Duo-Servo Brake.

The portion of the parking brake from the equalizer on back to the rear wheel brake is shown below. The parking brake components also are shown removed from the wheel brake for identification.


PARKING BRAKE LEVER
EQUALIZER
PARKING BRAKE STRUT
PARKING BRAKE CABLE
SECONDARY BRAKE SHOE
LEFT REAR BRAKE

Components of Integral Parking Brake

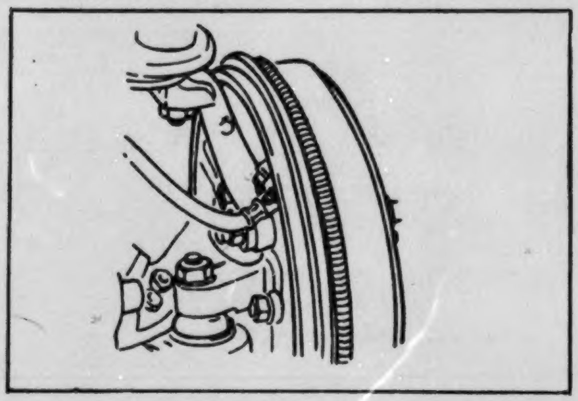
PARKING BRAKE HARDWARE SERVICE

To check the rear axle parking brake, pull on the cable and shoe linkage to make sure the movement does not bind and hold the shoes expanded. When replacing brake shoe assemblies, the strut, lever, and attaching parts must be transfered. Lube any points of potential bind in the linkage and the cable.

BRAKE DRUMS

BRAKE DRUMS - DESCRIPTION

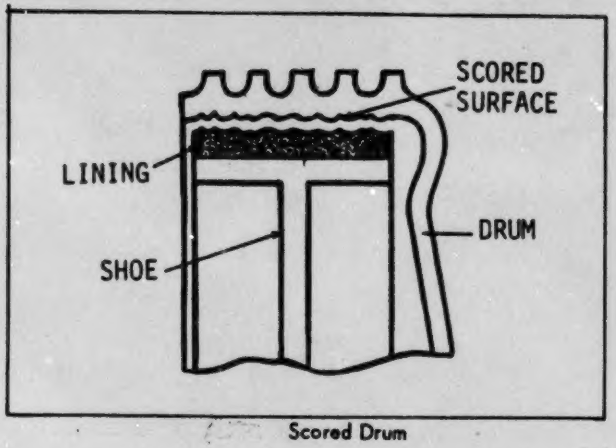
A brake drum is made of heavy cast iron and has a machined inner surface which is contacted by the brake lining during stopping action. The brake drum, thus, provides the rubbing surface for the linings. The drums must be able to withstand high pressure without excessive flexing and to dissipate the large quantities of heat generated during brake applications. Design variations may include the addition of fins or ridges to the drum casting to aid heat dissipation. Some drums are made of aluminum which is cast around a steel liner.



Some drums utilize noise dampening devices. Noises are amplified by resonance in the drum enclosure. Locating the origin of vibrations and dampening the oscillations before they enter the brake is important. Some drums are wrapped in a coil (screen door) spring which has the effect of changing the frequency of vibrations so they become inaudible or are cancelled out.

DRUM INSPECTION AND SERVICE

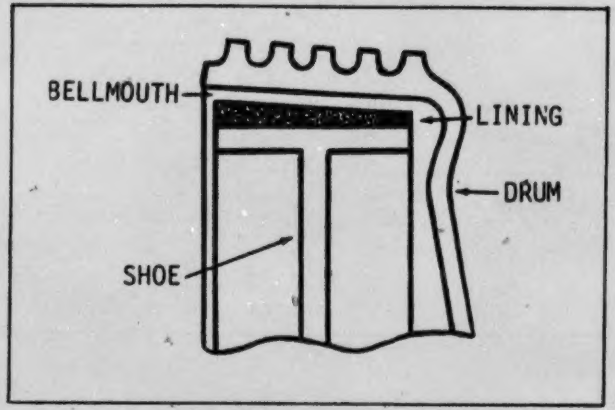
Drum defects resulting from normal wear and those resulting from abuse both often show up visually. If damage is excessive, the drum must be reconditioned or replaced as part of a complete brake job. Failure to correct brake drum defects may result in abnormal operation or a possible dangerous condition.



Scored Drum

Scored Drum

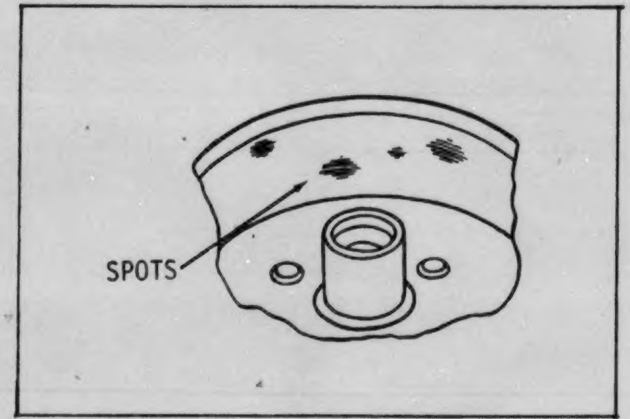
If the total drum scoring is not ragged or rough and if the scoring does not exceed .005" in depth, the drum may by used as it is. Rough or excessively scored drums cause rapid lining wear.



Straight Taper or Bellmouth Drum

Straight Taper or Bellmouth Drum

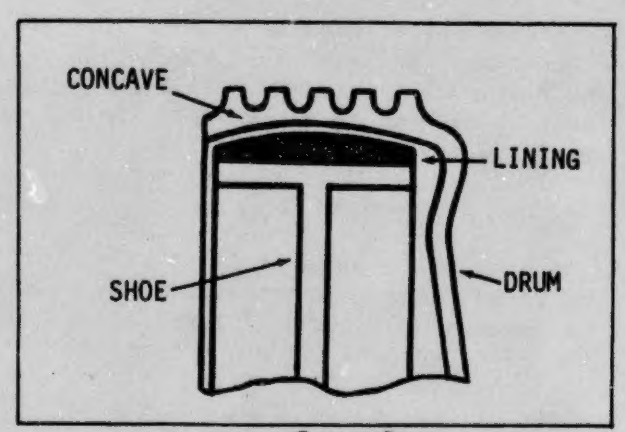
A drum may be used as it is if it has a straight taper across the face not exceeding .005" on the radius. Drums with bellmouth in excess of this limit prevent proper adjustment to provide a normal pedal height.



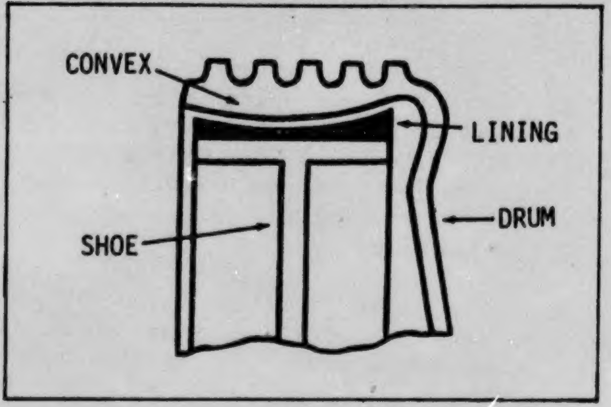
Hard or Chill Spotted Drum

Hard or Chill Spotted Drum

The drum may be used as it is if the hard spots do not introduce noticeable effects such as pedal pulsations and roughness. Drums with hard or chilled spots cause pedal pulsation or brake surge at slow speeds.


CONCAVE
LINING
SHOE
DRUM

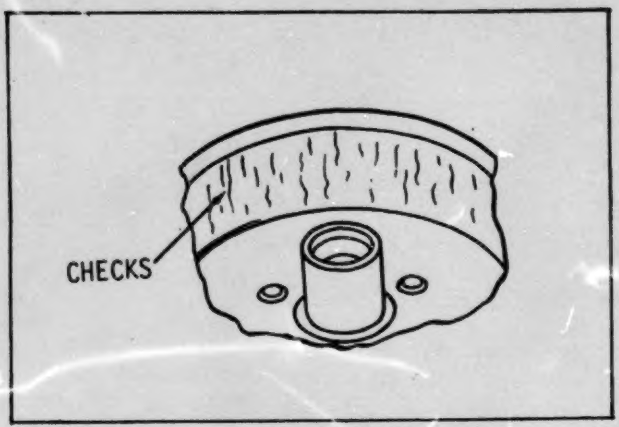
Concave Drum


CONVEX
LINING
DRUM
SHOE

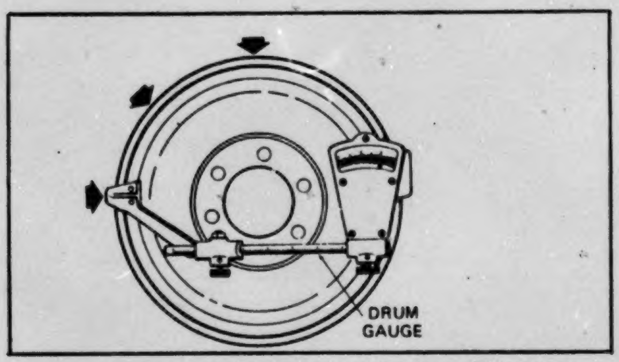
Convex Drum

Concave or Convex Drum

The drum may be used as it is if the surface variance does not exceed .005" on the side. Concave or convex drums in excess of this limit cause ineffective brakes and rapid lining wear.



Heat Checked Drum



Accurately Measuring the Drum Diameter

Heat Checked Drum

The drum may be used as it is if the heat checks are barely visible and cannot be felt with the finger nail. Rough, heat checked drums cause rapid lining wear and may cause drum failure.

Out of Round Drum

The drum may be used as it is if the out of round condition on the diameter does not exceed 0.010" and if pedal pulsation or brake roughness is not evident in light braking. Drums excessively out of round prevent close brake adjustment and results in erratic operation.

Oversize Drum

In general, a drum which is worn or rebored in excess of .060" more than the original diameter or car manufacturer specifications must be replaced. Oversize drums cause brake fade loss of pedal and brake noise.

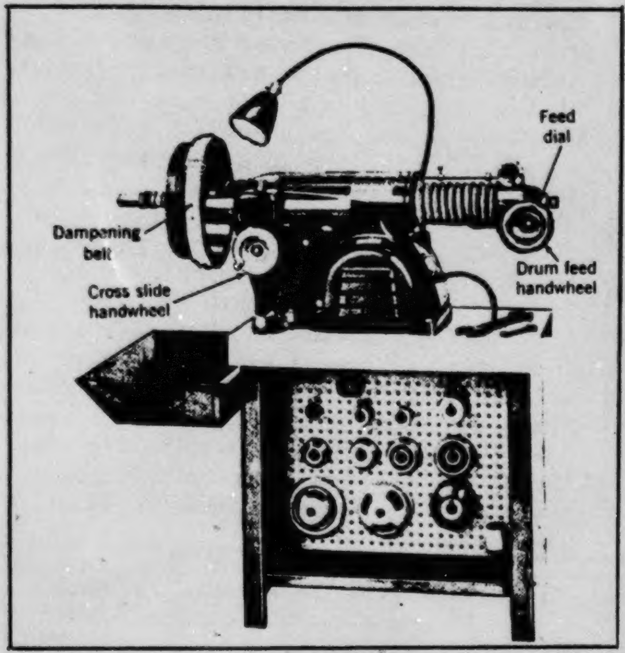
Drums must also be within 0.010" of each other on the opposite ends of the same axle to assure equal braking effort on all wheels.

Best shop practice requires measuring every drum with a drum micrometer regardless of visual inspection. Gauge the diameter at various points, over the span of the surface, 45 degrees apart around the circumference and at the bottom of the deepest groove to determine whether to rebore or to discard. Eccentric (out-of-round) distortion should not exceed 0.010" (0.25mm). If the drums are not to be rebored when installing the new lining, prepare the old drum surfaces by dressing them with fine emery cloth or steel wool or by lightly grinding them on a drum lathe.

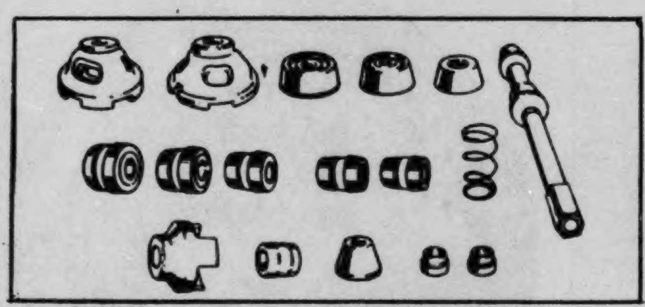
If all the above conditions are not satisfied and the need of drum service is indicated, the drums may be rebored within limits or must be replaced.

Prior to installing a new drum, be sure to remove all of the protective coating from the drum. This can best be done using a good commercial solvent. If all of the coating is not removed, the brakes will pull or grab.

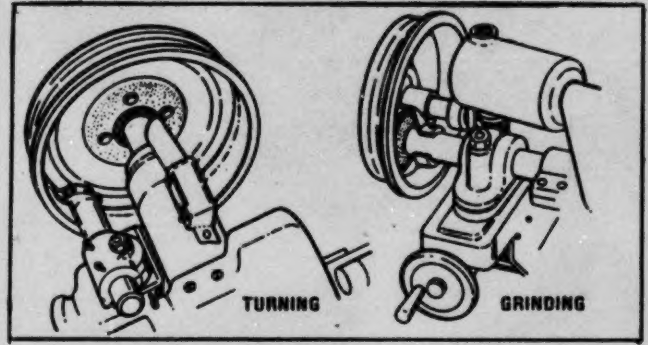
BRAKE DRUM MACHINING



A typical brake drum lathe (courtesy AMMCO TOOLS, Inc.)



A set of accessories furnished with a brake drum lathe (courtesy AMMCO TOOLS, Inc.)



Brake Drum Remachining

When remachining, follow the equipment instructions which define the specific characteristics of the drum lathe.

These general rules are always applicable.

1. Use sharp cutting tools.
2. Remachine the front and rear pairs to within 0.010" of each other.
3. With a hub mounted drum, wheel dismounted or mounted, wheel nuts should be re-installed to the same torque tightness before remachining. Torqued nuts reinforce the drum, reduce the possibility of distortion or chatter.
4. Different makes of lathes will permit finishing the drum surface with either a finecut, grind, or hone to remove spiral tool marks. If spiral marks remain, brake shoes are forced to "thread out". This can cause faster lining wear, "clicking" as shoes snap back against the support pads and, more important, interfere with shoe alignment during the braking action.
5. If the re-boring tool chatters over hard spots in the drum surface, grind the surface or discard the drum.

Brakes - Drum Brakes

No. C-4 Brake Parts - Inspection and Service

Information Sheet # 4
Page 6

MAX-DIA 12.09

A brake drum with cooling fins (General Motors).

In order to provide a safe wear allowance for reuse with new replacement lining, rebored brake drums must not exceed the safe maximum diameter originally marked on the drum. When the drum is not marked, drums up to and including 14" (356 mm) inside diameter should not be re-bored larger than 0.060" (1.524 mm) above the original diameter; 15" (381 mm) and 16" (406 mm) truck drums not more than 0.080" (2.032 mm) above the original diameter. Certain exceptions to this 0.060" (1.524 mm) limit and exceptions to the usual even-inch original drum diameter are charted below. If the re-bore exceeds the high limit, it could permit the drum to wear past the same discard point before the lining wears out. In certain states, reusing such a drum violates legal safety restrictions.

	Vehicle	Original Diameter inches/mm	Do Not Rebore Beyond inches/mm
Exceptions to the 0.060 rule ↓	Ford-Mercury 1964-61, 11¹⁄₃₂" (280.16 mm) dia. brake	11.030/280.16	11.060/280.92
	Buick 1967-66, 12" (305 mm) dia. brake	12.000/305.00	12.080/306.83
Exceptions to the usual "even inch" original drum diameter ↕	Buick, Chevrolet, GMC Truck, Oldsmobile, Pontiac, all makes and models with 9½" (241.3 mm) dia. brakes	9.500/241.3	9.560/242.82
	Ford-Mercury (except 1964-61 models), 11¹⁄₃₂" (280.16 mm) dia. brake Lincoln Mark III 11¹⁄₃₂" (280.16 mm) dia. brake Thunderbird (except 1966-63), 11¹⁄₃₂" (280.16 mm) dia. brake	11.030/280.16	11.090/281.69
	Lincoln, 1962-60, 11¹⁄₁₆" (280.92 mm) dia. brake	11.060/280.92	11.120/282.45
	Lincoln (except 1962-60 and Mark III), 11³⁄₃₂" (281.69 mm) dia. brake Thunderbird, 1966-63, 11³⁄₃₂" (281.69 mm) dia. brake	11.090/281.69	11.150/283.2
	Chevrolet, GMC Truck front axle 11⅛" (282.58 mm) dia. brake	11.125/282.58	11.185/284.10

CLEANING BRAKE DRUMS

The friction surface of the newly refaced drum contains millions of tiny metal particles. These particles not only remain free on the surface, but lodge themselves in the open pores of the newly machined surface. If the metal particles are allowed to remain in the drum, they get imbedded in the brake lining.

Once the brake lining gets contaminated in this manner, it acts as a fine grinding stone and scores the drum. The metal particles must, therefore, be removed by washing or cleaning the drum. Do not blow out the uncleaned drum with air pressure.

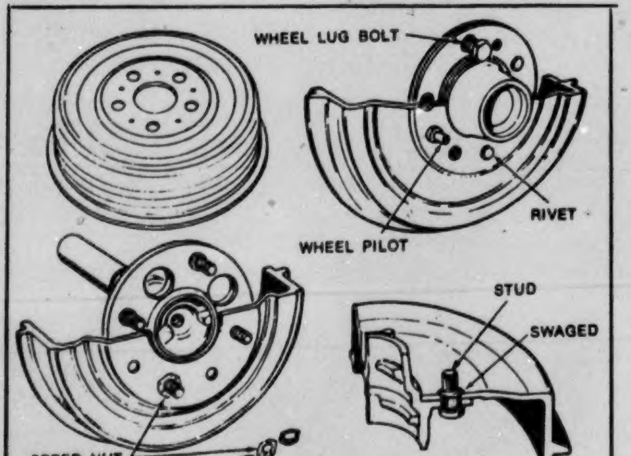
Either of the following methods is recommended to clean the newly refaced brake drum:

a) Wash the brake drum thoroughly with hot water and wipe with lint-free rag. Then use the air pressure to thoroughly dry it. If the front hub and drums are being cleaned, be very careful to avoid contamination of the wheel bearing grease. Or, completely remove all old grease and then regrease and repack the wheel bearing after the drum has been cleaned and dried. The wheel bearings and the grease seals MUST be removed from the drum before cleaning.

b) Wipe the inside of the brake drum, especially the newly machined surface, with a lint-free white cloth dipped in one of the many available brake cleaning solvents that do not leave a residue. This operation should be repeated until dirt is no longer apparent on the wiping cloth. Allow the drum to dry before reinstalling it on the vehicle.

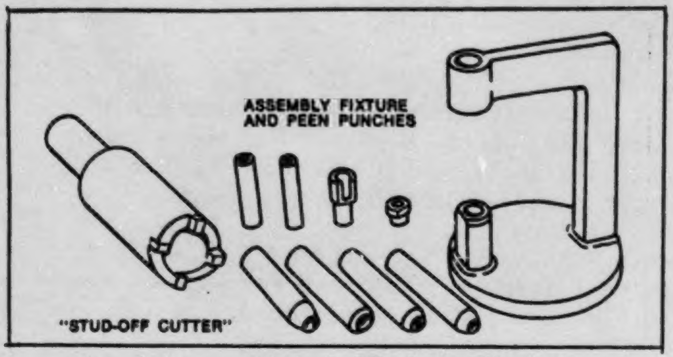
REPLACING BRAKE DRUMS AND HUBS

The replacement of badly worn or damaged brake drums or the replacement of a damaged hub within a useable drum may require special tools and techniques. The following illustrates some methods currently in use.



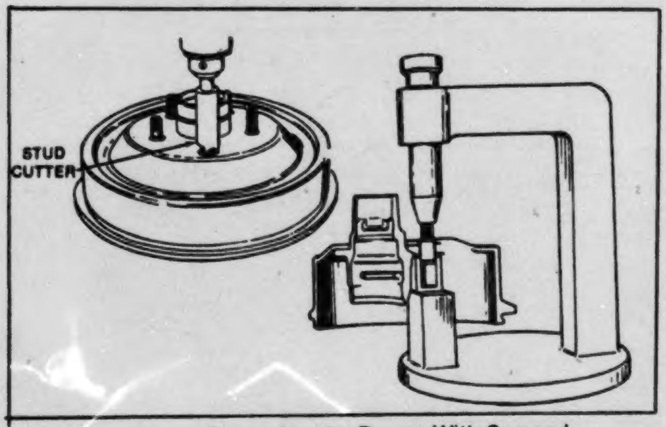
Assembly Methods of Holding Drums

In order to hold the drums in their piloted positions while the wheels are dismounted, several assembly methods are in use. When the original drum is mounted against a wheel hub flange, it may be fastened with rivets, or by swaging the piloting shoulders of the wheel studs, or with speed nut fasteners installed over the threads of the wheel studs. When the drum is mounted against a drive axle shaft flange, it is fastened with speed nuts or small machine screws.



Method of Replacing Riveted or Swaged Stud Type Drums

Methods for replacing riveted or swaged stud types require a shop press (8 to 12 ton capacity), a press drum assembly fixture equipped with several sizes of peen punches and a "stud-off cutter" for milling (shaving) down the swaged surface of stud shoulders.

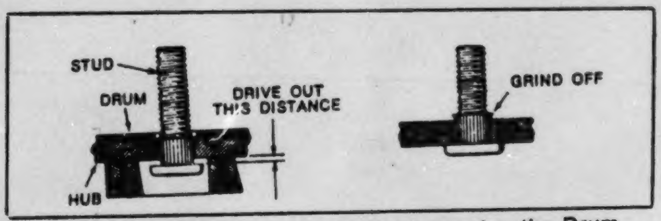


Removing the Drums With Swaged Stud Mounts

Removing Old Drums

-Drums with threaded fasteners--Unthread the speed nuts or machine screws, and lif the drum off the flange.

-Drums with riveted mounts--With a chisel, shear off the upset ends of rivets. Punch or drill out the rivet shanks and separate the hub from the drum. Drums with swaged stud mounts--Chuck the stud-off cutter in an electric drill. Align the cutter over each stud thread, in turn, and mill off the swaged material. Separate the hub from the drum and press the studs from the hub. If the old studs must be re-used, do not shave off more than 2/3 of their pilot shoulders protruding from the hub flange. Otherwise, the studs should be replaced.



Alternate Method of Removing the Drum

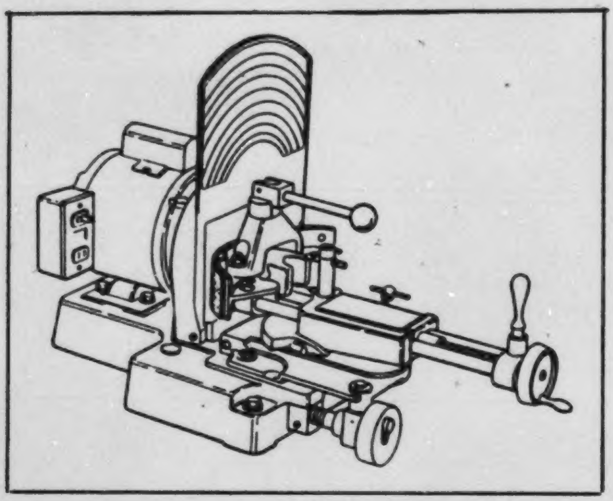
Alternately, the studs can be pressed or driven out only enough to bend back the swaging and pop off the drum. Then reset the studs in the hub and grind or file off the swaged material before forcing the studs through the hub flange.

BRAKE SHOE ARC GRINDING

The actual diameter of a brake drum after machining may vary from 0.005 to 0.060 in oversize. New or relined brake shoes cannot possibly fit all the drums when the drums vary in diameter. Of course, the shoes will eventually wear in, but they will do so only after thousands of miles of use. If you want to turn out a perfect brake job, you must machine the brake lining to fit the friction surface of the drum. This machining is called "arc grinding". Arc grinding is necessary for several reasons:

1. To fit the lining to a drum that has been machined to an oversize diameter.
2. To allow for slight misalignment and a possible stackup of manufacturing tolerances.
3. To allow a slight shoe flexing to minimize the possibility of brake noise.

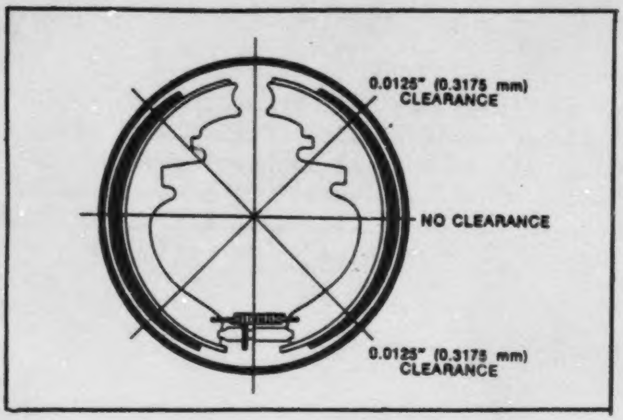
Most manufacturers recommend that standard linings be installed when the actual drum diameter does not exceed 0.030" oversize. This procedure usually results in a satisfactory lining-to-drum contact that will improve with wear in a short time. In some areas oversize linings are available to fit drums that have been machined to 0.030" or more oversize. When these are not available, however, standard size linings must be arc ground to fit.



Grinder Set-up

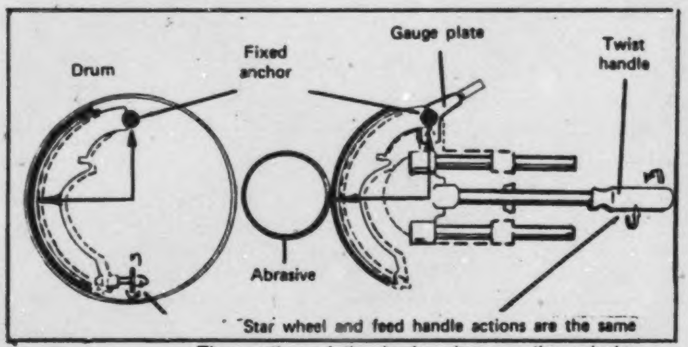
Specialized equipment for arc grinding brake shoes is usually included with drum remachining equipment.

All brake shoe grinders operate on a common principle. The brake shoe is clamped into a fixture that allows the shoe to be moved in an arc across an abrasive disc or drum. The arc is adjustable so that the lining can be ground to fit any size drum.


0.0125" (0.3175 mm)
CLEARANCE
NO CLEARANCE
0.0125" (0.3175 mm)
CLEARANCE

—Contour (Eccentric) Grind—

Brake shoe radius can be adjusted on most shoe grinders. The best initial braking is obtained when the lining is ground to a diameter of 0.030 in. less than the actual diameter of the drum. Most brake shoe arc grinders automatically provide that difference. The actual diameter of each drum is found by measurement. Then the grinder can be adjusted to grind each pair of shoes to fit the drum they will be used with. It is important that, when grinding the finishing cut, lining material is removed from the entire surface in one sweeping arc.


Drum
Fixed anchor
Gauge plate
Twist handle
Abrasive
Star wheel and feed handle actions are the same

The motion of the brake shoe on the grinder duplicates the motion of the shoe on the backing plate when the star wheel adjuster is turned (courtesy AMMCO TOOLS, Inc.)

Some brake shoe arc grinders mount the shoe against a special gauge plate which duplicates the shoe anchor position for the type and size of brake being serviced. The method, called "fixed anchor grinding", may have some advantages in achieving a closely matched contour.

CAUTION: No matter what type equipment is used, make sure that a good dust collecting system is operational and that a filtering respirator be worn to protect from asbestos hazards while grinding linings.

Auto Mechanics

Drum Brake Repair and Service

No. C-5

OBJECTIVE: Upon completion of this unit the student will be able to rebuild complete drum brake assemblies at a level producing safe operating conditions.

EXPLANATION: This unit will cover the machining and repair involved in the complete drum brake system.

MATERIALS NEEDED: Safety glasses

TOOLS NEEDED:

References	Do
#1. Chapter 29 pp. 21-22	1. Read assigned references.
#2. Chapter 18	2. Read information sheets.
#3. 537	3. Check with instructor.
#4. Chapter 27 pp. 441-446	4. Complete the test.
#5. Chapter 41 pp. 524-525	5. Check with instructor.
#6. Chapter 41 pp. 574-578	
#7.	
#8.	

Brakes - Drum Brakes

No. C-5 Drum Brake Repair
and Service

Information Sheet # 1
Page 1

GENERAL DRUM BRAKE SERVICING PROCEDURES

The following procedure lists general steps and working methods to be followed during a drum brake overhaul. Since specific differences may exist among different brake designs, you should also check the specific disassembly/assembly steps and the illustration detailing the particular brake type being serviced. These are located later in this section.

Step 1: Raise car with jack and support on stands. Follow safety precautions in Section C-1 to avoid personal injury and damage to the vehicle.

Step 2: Inspect the hydraulic system for deteriorated lines and hoses. Press the brake pedal to ensure that there are no leaks in the hydraulic system. If the pedal does not remain hard, and drops to the floor, it is an indication of a leak in the master cylinder, hoses, wheel cylinders, or disc brake calipers. When performing this test, the engine should be running if the car is equipped with power brakes. With power brakes it is normal for the pedal to drop slightly when the engine starts. If it continues to drop, start looking for a leak.

Step 3: Remove wheels and brake drums.

Front drums: Front brake drums are usually (but not always) fastened to the front hub. Remove dust cap, cotter key, spindle nut, and hub - bearing-drum assembly. Remove bearings and inside seal. Set bearings aside for later repacking. Wipe and wash grease out of hub.

Rear Drums: Rear drums are usually of the floating type not rigidly fastened to the axle. Remove speed nuts (if used) from wheel studs and slide drum from axle flange.

Drums do not come off easily: Brake drum removal may be hampered by:

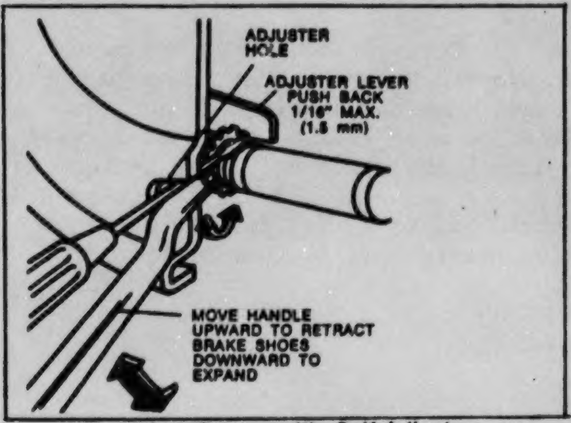
a. shoes being worn into the friction surface of the drum -- leaving a lip on the inside edge to hang up during removal.

b. emergency brakes on or adjusted too tight (rear brakes), and

c. drum center rusted to axle flange (rear brakes).

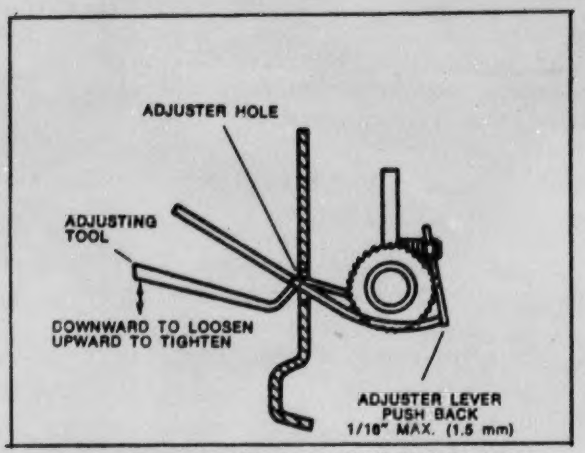
If brake drums are hanging up on the shoes, their adjusting mechanism will have to be backed off or loosened. Access to the adjusting star wheel can be gained through a slot in the backing plate or drum.

On some cars with automatic adjusters, a knock-out slug must be removed from the backing plate or drum for access to the adjusting screw. If the knock-out slug is removed from the backing plate, replace it with a rubber hole cover. If the knock-out slug is removed from the drum, replace it with a metal hole cover. Be sure to remove the slug and any metal chips from inside the drum.

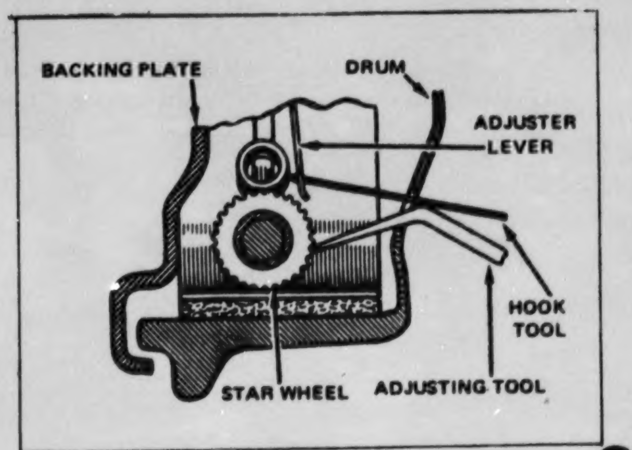

ADJUSTER HOLE
ADJUSTER LEVER PUSH BACK 1/16" MAX. (1.5 mm)
MOVE HANDLE UPWARD TO RETRACT BRAKE SHOES DOWNWARD TO EXPAND

Removing Drums with Self-Adjusters on Most Models

In order to turn the star wheel adjuster back, the automatic adjuster must be released. To do this, reach in through the adjusting slot with a very small screwdriver (or similar tool) and carefully push the self-adjusting lever away from the star wheel by a maximum of 1/16" (1.5 mm). While holding the lever back, insert the brake adjusting tool into the slot and turn the star wheel in the proper direction until the brake drum can be removed.


ADJUSTER HOLE
ADJUSTING TOOL
DOWNWARD TO LOOSEN UPWARD TO TIGHTEN
ADJUSTER LEVER PUSH BACK 1/16" MAX. (1.5 mm)

Removing Drums with Self-Adjusters on Chrysler Models


BACKING PLATE
DRUM
ADJUSTER LEVER
HOOK TOOL
STAR WHEEL
ADJUSTING TOOL

With Adjusting Slot in Brake Drum

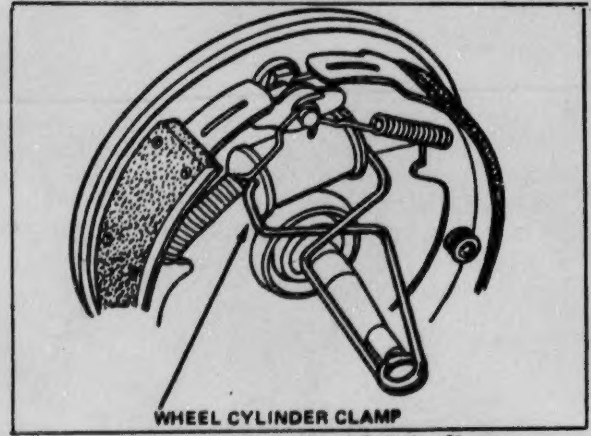
If the brake drum is frozen (rusted) to the rear axle flange, heat the drum around the center hole until it expands enough to be pulled free.

CAUTION: Asbestos dust is a health hazard. After removing drums, use a filtered vacuum cleaner to clean the inside of the drum and the brake assembly. DO NOT BLOW OFF PARTS WITH COMPRESSED AIR. If a vacuum cleaner is not available, use a damp rag. A respirator should be worn to prevent dust from entering lungs.

Step 4: Inspect brake drums. (See section C-4, information sheet #4.) Diagnose the drum condition visually and by measuring with a drum micrometer, compare size to specifications and determine proper drum servicing.

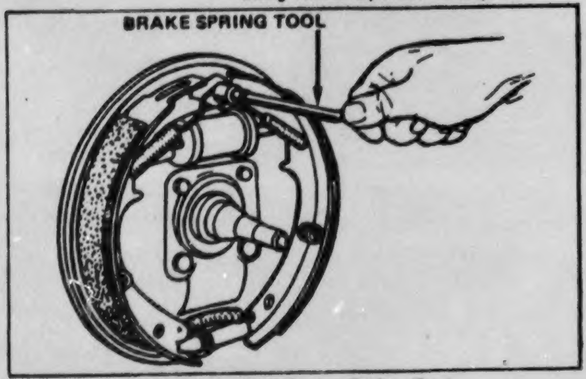
Step 5: Remove brake shoes and hardware from the backing plate as follows:

Note: At this time you should locate or sketch a diagram of the brake assembly showing the exact location of all parts -- especially automatic adjusting parts. As an alternative, disassemble only one brake at a time using the opposite brake as a reference during reassembly.



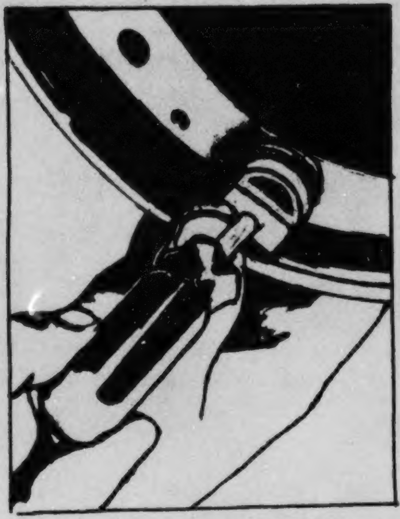
Using Wheel Cylinder Clamps

a. If the brake design does not use piston stops, a wheel cylinder clamp should be installed. This will prevent loss of wheel cylinder parts during brake disassembly.



Using Brake Spring Tool

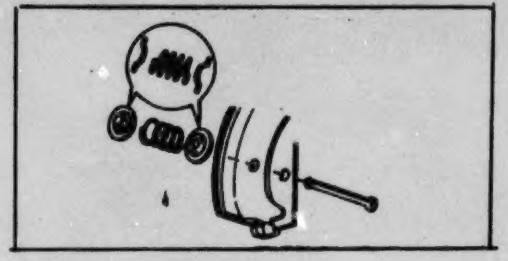
b. Remove shoe return springs using a brake spring tool. Position the tool over the end of the anchor. Twisting the tool will hook the spring end out of its groove allowing it to be pulled from the anchor. Note exact position of different colored springs.

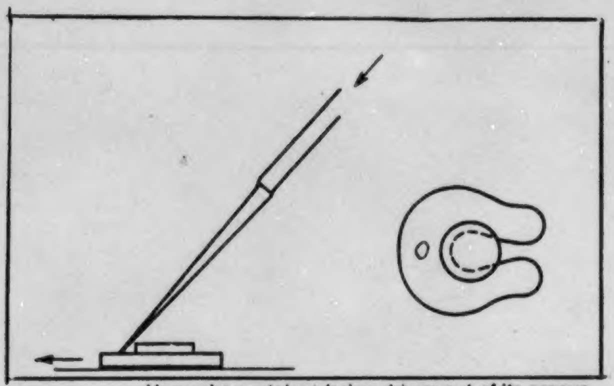


Removing a hold-down assembly.

c. Remove shoe hold-downs using a hold-down tool. Position the tool against the end cap while holding the pin head against the back of the support plate. Push in and turn the tool against the end cap to release assembly.

d. Remove automatic adjuster hardware.

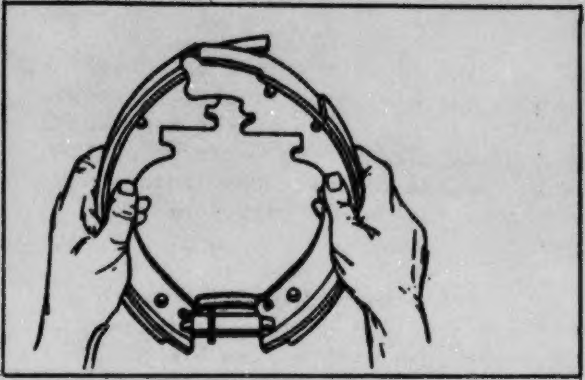




Horseshoe retainer being driven out of its groove.

e. On rear brakes, remove the emergency brake lever. Horseshoe type retainers can be removed by first indenting with a punch and then driving at an angle to slide it out of its groove.

f. Grasp the shoes, one in each hand. Spread them apart slightly to disengage them from the wheel-cylinder push rods, and remove them from the backing plate.



Twisting the shoes so that they will overlap
(Bendix Automotive Aftermarket Operations).

g. Twist the shoes slightly, and allow them to come together. As they overlap, the spring will relax. The adjuster and spring can now be removed.

NOTE: Do not mix star wheel adjusters. Usually, the right side of the car will have left hand threads and the left side of the car will use right hand threads, (except Chrysler upstroke types).

Step 6: Rebuild or replace wheel cylinders. (See section C-1, Wheel Cylinders.)

NOTE: Before attempting to rebuild a wheel cylinder, make sure that the bleeder screw can be loosened. A frozen or broken bleeder screw may require wheel cylinder replacement.

It is recommended that wheel cylinders always be rebuilt during brake shoe replacement. Although the wheel cylinders do not appear to leak at the time the old shoes are removed, leakage may develope because of the new shoe installation. New brake shoes with thicker linings will force the pistons and cups of the wheel cylinder back into their bore. This will position the sealing cups over an area that has been collecting rust and sediment for some time. When the cups are operated in this area these deposits will damage the sealing capability and cause eventual leakage. Brake fluid leaking onto linings can cause the brakes to pull, grab, or drag. In the end, if an accident occured, the mechanic may be held liable for injury and damages due to negligence or "faulty workmanship".

Step 7: Clean, inspect and lubricate brake parts.

CAUTION: Brake parts should not be cleaned with an oil based solvent as this leaves an oily residue which can damage the rubber parts of the hydraulic system and glaze brake linings. One of the many commercially available alcohol based brake cleaning solvents should be used for all parts. After cleaning, avoid touching the linings and drum friction surface with your hands. Greasy fingerprints will affect brake operation.

a. With all the brake parts off, clean the backing plate with a damp cloth to avoid raising any asbestos dust, and dispose of the rag after use. Clean any rust with a wire brush. Lubricate the brake shoe contact points on the backing plate, and file smooth any ridges or rough edges. Clean and lightly lubricate the adjuster threads, and screw the adjuster all the way together to facilitate reassembly later on. Check backing plate bolts to make sure they are tight.

b. On front brakes, wash the wheel bearings in solvent and repack with proper grease. Use new seals.

c. Carefully inspect all parts for wear and damage. (Section C-4, information sheet #3, details hardware inspection and individual service.)

Step 8: Assembly brake shoes and hardware to backing plate.

Special Notes:

-- Brake shoes are different within each axle set. The primary brake shoe is the one toward the front of the car, and its lining is usually shorter than that on the secondary (rearward) shoe.

-- Self-adjusting mechanisms are usually mounted on the secondary shoe.

-- The star wheel part of an adjuster usually (but not always) goes toward the rear of the car.

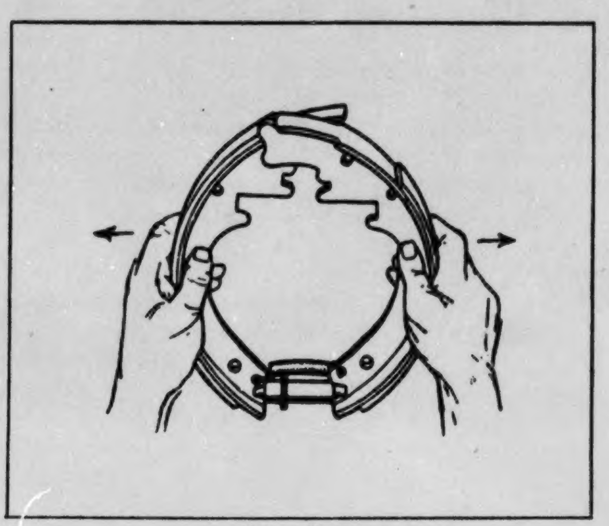
-- Different color springs belong in different locations.

-- Self-adjusters and related parts are not interchangeable from one side of a car to the other since the direction of adjuster rotation varies from one side of a car to the other.

-- Never press the brake pedal when one or more brake drums are off, or a wheel cylinder will pop apart.

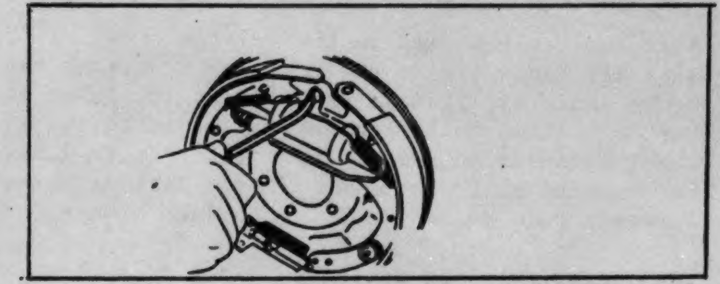
a. Reassembly the brakes in the reverse order of disassembly. Make sure all parts are in their proper locations and that both brake shoes are properly positioned in either end of the adjuster. Also, both brake shoes should correctly engage the wheel cylinder push rods and parking brake links, and should be centered on the backing plate. Parking brake links and levers should be in place on the rear brakes.

b. Lay the primary and secondary shoes on a clean surface in the position in which they will be installed on the backing plate. Install the adjuster spring, connecting both shoes. Raise one shoe slightly, and overlap the other shoe. Install the adjuster assembly, making sure that the star wheel is closer to the secondary shoe and that it lines up with the long end of the spring.



Removing/Installing Shoes

c. To install shoe return springs, insert the straight end of the spring tool through the spring loop. Place the slightly hooked end of the spring tool against the end of the shoe anchor and lever the tool away from the spring. This will cause the spring loop to slide along the tool and onto the anchor where it will snap into its groove.



Installing a retracting spring (K-D Manufacturing Company).

Step 9: Inspect for proper assembly and test automatic adjuster operation.

a. Check the installation of the shoes. To do so, grasp the shoes near the star adjuster, and move them back and forth. Observe the fit of the shoes at the backing plate, anchor pin, and wheel-sylinder push rods.

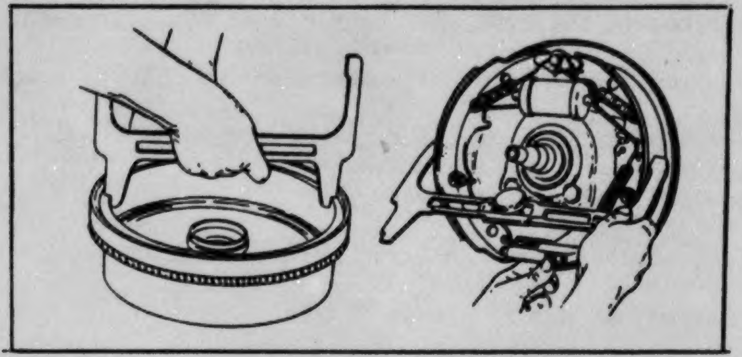
b. Check the operation of the self-adjuster by pushing down on the lever or pulling on the cable. The pawl should rotate the star wheel easily, and the return spring should push the lever back up when you release it. As the star wheel turns, it should lengthen.

NOTE: Repeat all removal and installation steps on the opposite wheel. Any part you replace on one side must be replaced on the opposite side if even braking is to be obtained.

Step 10: Make initial adjustment of brake shoes.

Method I: Clearance Gauge

Whenever brake shoes are replaced, they must be adjusted. Most manufacturers recommend the use of a clearance gauge similar to the type shown below. This tool enables you to adjust the brakes before you install the drums. This can save you a lot of time, becuase then you can turn the star wheel adjusters with your fingers.



Brake Lining Adjustment

To adjust shoes:

a. Place the clearance gauge inside the brake drum, and expand the gauge to the inner diameter of the drum. Lock the gauge to retain this measurement.

b. Place the gauge horizontally over the brake assembly. Turn the star wheel to expand the shoes until they make contact with the gauge.

c. Repeat this adjustment procedure at the remaining wheel.

d. Finish the brake job by repacking the wheel bearings and installing the drums.

Method II: Use a Brake Drum as a Gauge

a. Turn the star wheel adjuster so that the shoes are expanded slightly.

b. Slip the drum over the shoes, and feel for contact with the lining.

c. Repeat steps 1 and 2 until you feel the shoes dragging in the drum as you slide it in place.

d. Remove the drum, and back off on the star wheel one full turn.

e. Install the drum, and check to see that it spins freely.

f. Repeat this procedure on the opposite wheel.

Step 11: Bleed brake hydraulic system.

Bleed the brake system using methods covered in Section B-3.

Step 12: Final adjust and road test brakes.

a. Install wheels using a torque wrench and following the tightening patterns shown on the following page. Torque 60-70 Ft Lbs. Uneven torque can distort drums and cause brake problems.

b. Adjust front wheel bearings to specifications.

CAUTION: Before attempting to move car, make sure that you have some brake pedal feel.

c. Make the final adjustment when the wheels have been installed and the car is on the floor. Drive the car, making numerous forward and reverse stops and applying the brakes with a firm effort until you obtain a high pedal. The brake system should produce straight, smooth stops.

d. After the new linings have been installed, caution the driver to use care during the break-in period. Avoid high speed brake stops and severe brake applications during the first 500 miles. This will help to provide smoother brakes that last longer.

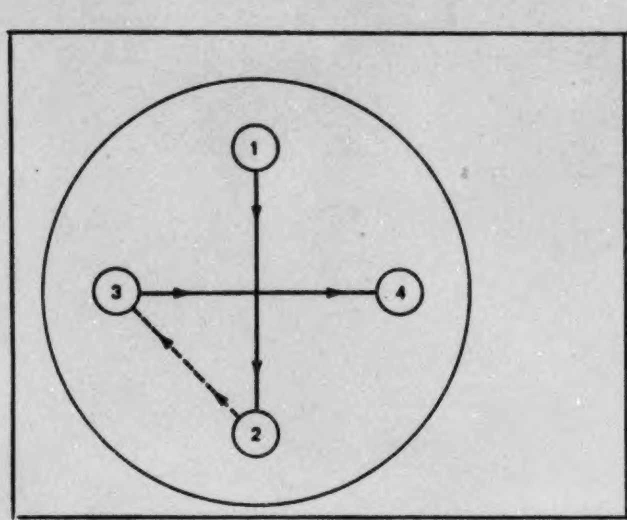


Figure 4.7 "Cross" pattern, recommended as the sequence for tightening lug nuts on a four-hole wheel.

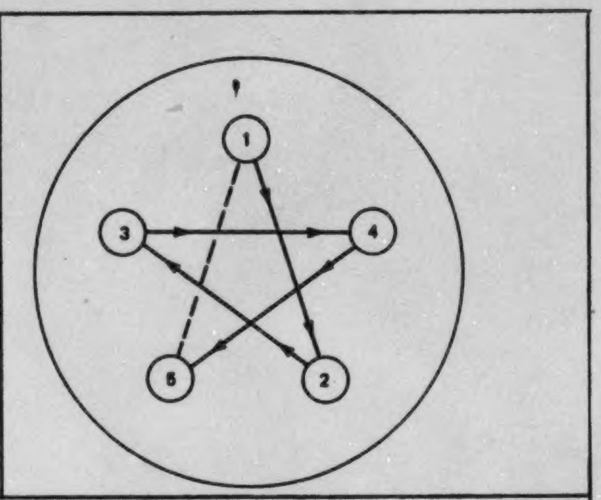


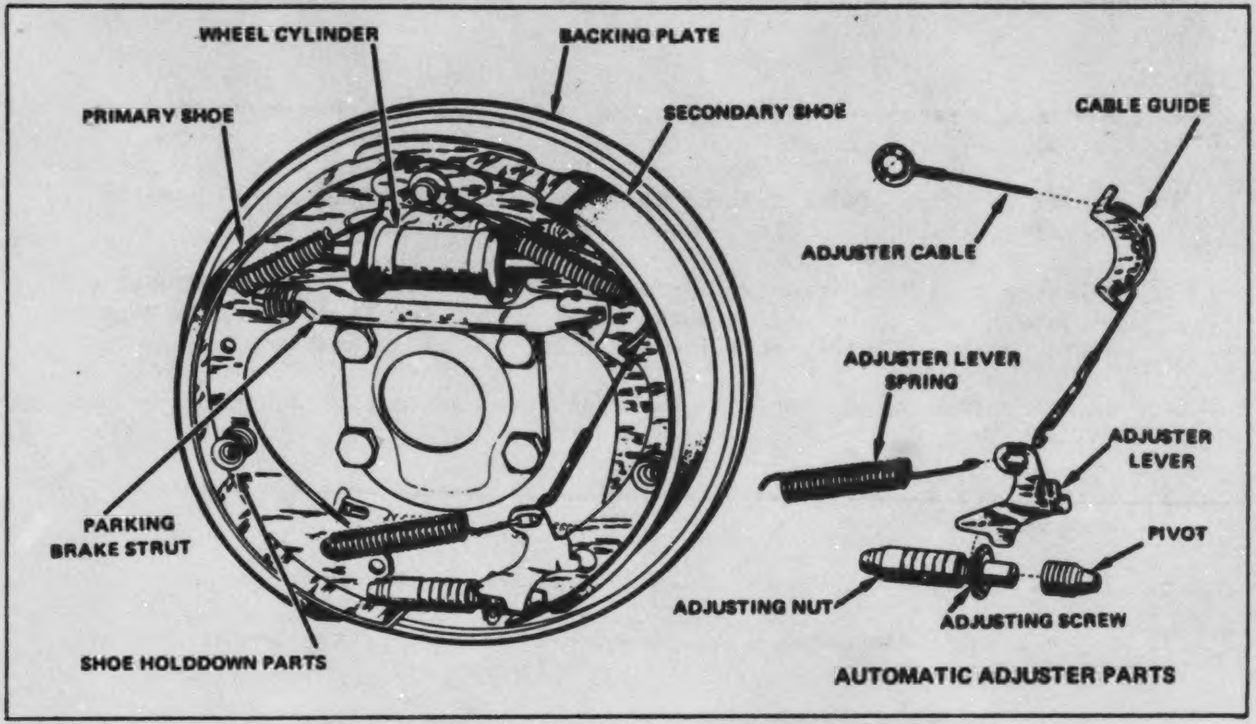
Figure 4.8 "Star" pattern, recommended as the sequence for tightening lug nuts on a five-hole wheel.

DESIGN APPLICATION

The following section presents a visual reference and specific disassembly/assembly information for most brake designs currently in use.

1. Bendix Duo-Servo -- used on most AMC, Ford, and pre-1969 Chrysler Corp. automobiles.
2. Bendix Duo-Servo (with application type automatic adjuster) -- used on Chrysler Corp. automobiles since 1969.
3. Delco-Moraine Duo-Servo (with pivot lever and override spring automatic adjuster) -- used on all GM automobiles except Cadillac, pre-1976 Vega, Astre, Monza, Skyhawk, Starfire, Sunbird, and all Chevettes.
4. Delco-Moraine Duo-Servo (with lever and pawl automatic adjuster) -- used on Cadillac.
5. Wagner Compound Servo (with link adjuster) used on some 1966-69 AMC automobiles.
6. Bendix Non-Servo -- used on some 1965-68 AMC automobiles.
7. Delco Moraine Non-Servo -- used on pre-1976 Vega, Astre, Monza, Skyhawk, Starfire, and Sunbird.
8. Chevette Non-Servo (with automatic cam adjusters) -- used on all Chevette models.
9. Omni-Horizon Non-Servo (manual adjusting) -- used by Dodge Omni and Plymouth Horizon automobiles.
10. Volkswagon Brake -- used on all Volkswagon models with drum brakes.

Bendix Duo-Servo Brake with Automatic Adjuster


WHEEL CYLINDER
BACKING PLATE
PRIMARY SHOE
SECONDARY SHOE
CABLE GUIDE
ADJUSTER CABLE
ADJUSTER LEVER SPRING
ADJUSTER LEVER
PIVOT
PARKING BRAKE STRUT
ADJUSTING NUT
ADJUSTING SCREW
SHOE HOLDDOWN PARTS
AUTOMATIC ADJUSTER PARTS

Typical Bendix Duo-Servo Brake With Automatic Adjuster (Left Rear Shown)

NOTE: These service procedures cover a rear brake. The service procedures for a front brake are the same except for references to parking brake parts.

DISASSEMBLY

1. Be sure that the parking brake is released.
2. Remove wheel and drum. If shoes interfere with drum removal, hold adjuster lever away from star wheel while backing off adjustment as shown in information sheet #1.

NOTE: Check position of return springs, holddown parts and automatic adjuster parts so that they can be re-installed in same position.

3. Install wheel cylinder clamp to hold wheel cylinder pistons in place.

4. Remove shoe return springs and automatic adjuster spring. Then remove automatic adjuster cable, cable guide, adjuster lever and shoe guide plate, if used.

5. Remove shoe holddown parts and adjusting screw. Remove parking brake strut with anti-rattle spring, and disconnect parking brake lever from secondary shoe.

RE-ASSEMBLY

1. Apply light coat of high temperature lubricant to shoe support points on backing plate and to adjusting screw threads.

2. Assembly parking brake lever on secondary shoe.

3. Assemble shoes on backing plate, and secure with holddown parts.

4. Assembly anti-rattle spring on parking brake strut, and then position strut between parking brake lever and primary shoe web.

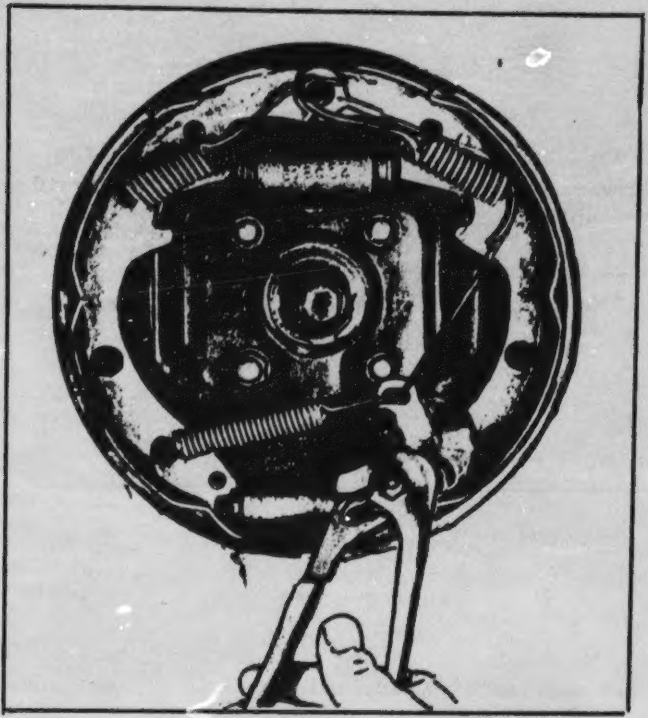
5. Position shoe guide plate and loop of adjuster cable on anchor pin. Then install primary shoe return spring.

6. Position cable guide on secondary shoe web, and then install secondary shoe return spring. Be sure that wheel cylinder shoe links properly engage shoe webs. Remove wheel cylinder clamp.

7. Assembly adjusting screw between shoe webs at lower end.

8. Attach short hook end of automatic adjuster spring to primary shoe web.

9. Attach other end of spring and hook of adjuster cable to hole in adjuster lever. Then assembly lever, with spring and cable attached, on secondary shoe web. (See next page.)



Using pliers to install an adjuster lever on the secondary shoe (courtesy American Motors Corporation).

Bendix Duo-Servo Brake with Application Type Automatic Adjuster

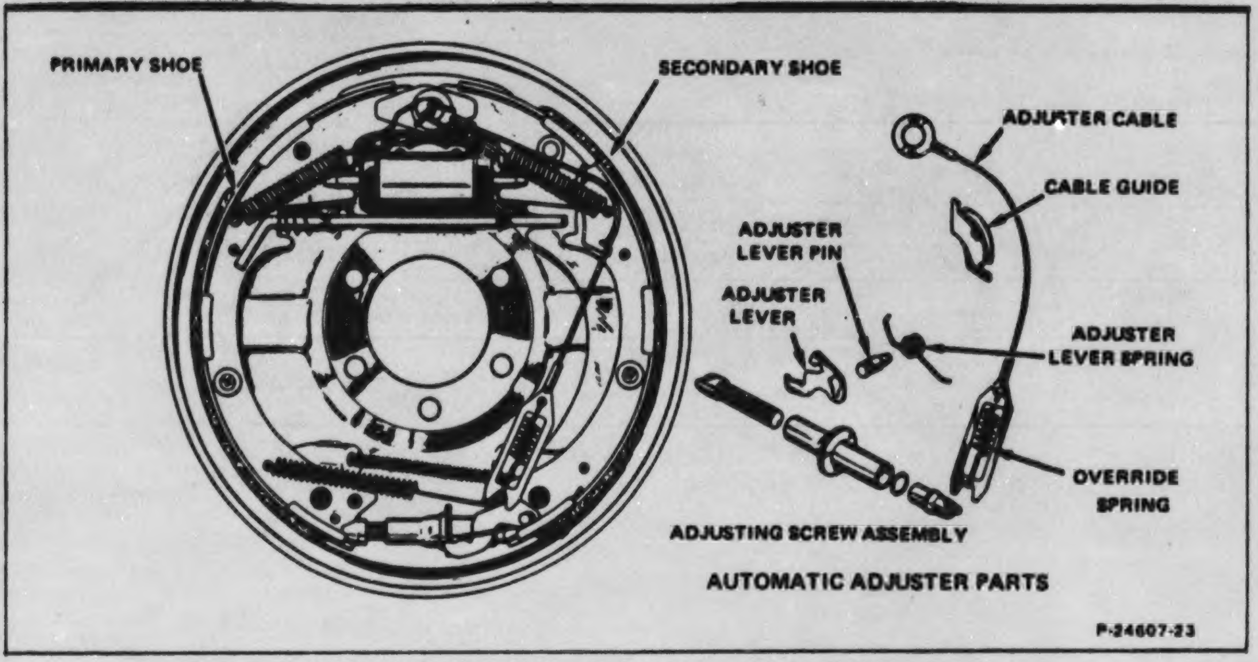

PRIMARY SHOE
SECONDARY SHOE
ADJUSTER CABLE
CABLE GUIDE
ADJUSTER LEVER PIN
ADJUSTER LEVER
ADJUSTER LEVER SPRING
OVERRIDE SPRING
ADJUSTING SCREW ASSEMBLY
AUTOMATIC ADJUSTER PARTS
P-24607-23

Figure 7. Typical Bendix Duo-Servo Brake - Application Type Adjuster (Left Rear Shown)

DISASSEMBLY

The disassembly procedures for this brake (Figure 7) are generally the same as those for the Bendix Duo-Servo Brake except as follows:

> Remove shoes, adjusting screw and lower shoe-to-shoe spring as an assembly. Then overlap anchor end of shoes to reduce spring tension, and remove spring and adjusting screw from shoes.

RE-ASSEMBLY

Same as Bendix Duo-Servo Brake except as follows:

1. Drive or press a new adjuster lever pin in small hole near lower end of each secondary whoe web. Install pins from side of shoe web facing outward when shoes are on car. Be sure that pins are fully seated.
2. Pre-assemble shoes, adjusting screw and shoe-to shoe spring as shown prior to installing shoes on backing plate.
3. Be sure that override spring is installed with open end of hook facing outward, toward the installer.

Duo-Servo Brake with Delco-Moraine Automatic Adjuster

(PIVOT LEVER AND OVERRIDE SPRING)

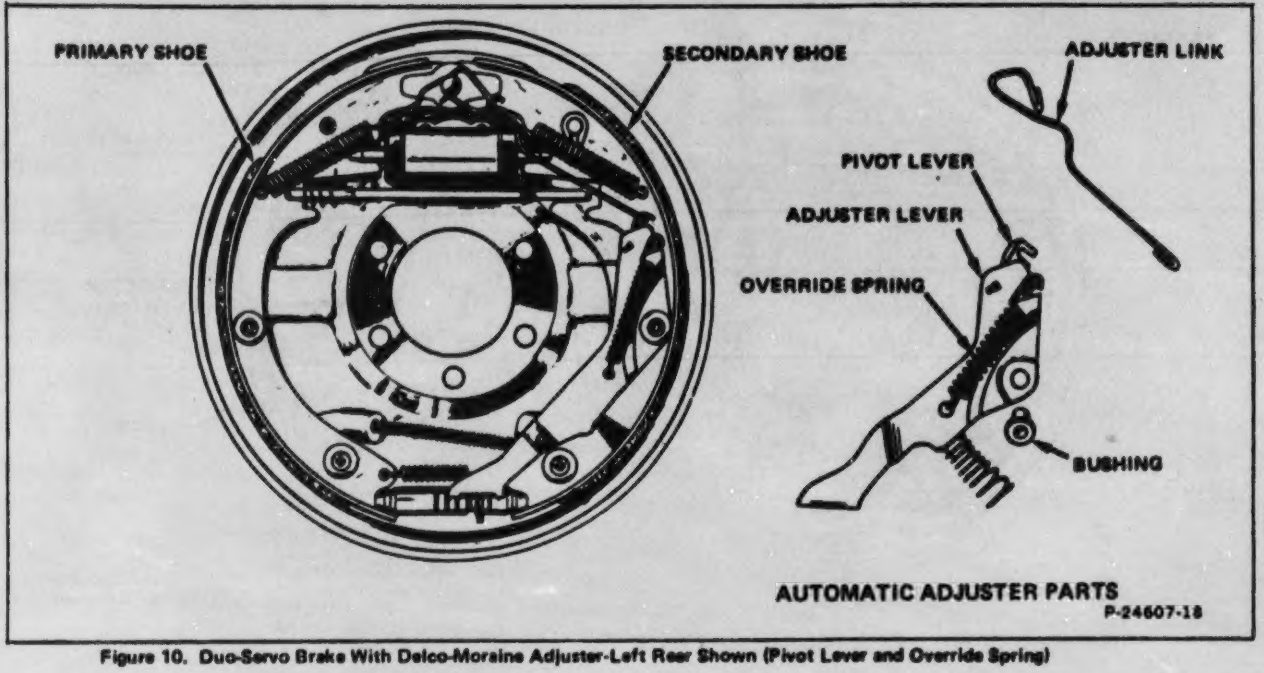

PRIMARY SHOE
SECONDARY SHOE
ADJUSTER LINK
PIVOT LEVER
ADJUSTER LEVER
OVERRIDE SPRING
BUSHING
AUTOMATIC ADJUSTER PARTS
P-24607-18

Figure 10. Duo-Servo Brake With Delco-Moraine Adjuster-Left Rear Shown (Pivot Lever and Override Spring)

NOTE: Some cars using this brake have a lanced area in the drum which must be punched out for access to the adjusting screw star wheel. If the lanced area is punched out, be sure that all metal particles are removed from inside the drum.

DISASSEMBLY

The disassembly procedures for this brake (Figure 10) are generally the same as those for the Bendix Duo-Servo Brake except as follows:

Remove shoes, adjusting screw and lower shoe-to-shoe spring as an assembly. Then overlap anchor end of shoes to reduce spring tension, and remove spring and adjusting screw from shoes.

RE-ASSEMBLY

Same as Bendix Duo-Servo Brake except as follows:

Pre-assembly shoes, adjusting screw and shoe-to-shoe spring prior to installing shoes on backing plate.

Duo-Servo Brake with Delco-Moraine Automatic Adjuster

(LEVER AND PAWL)

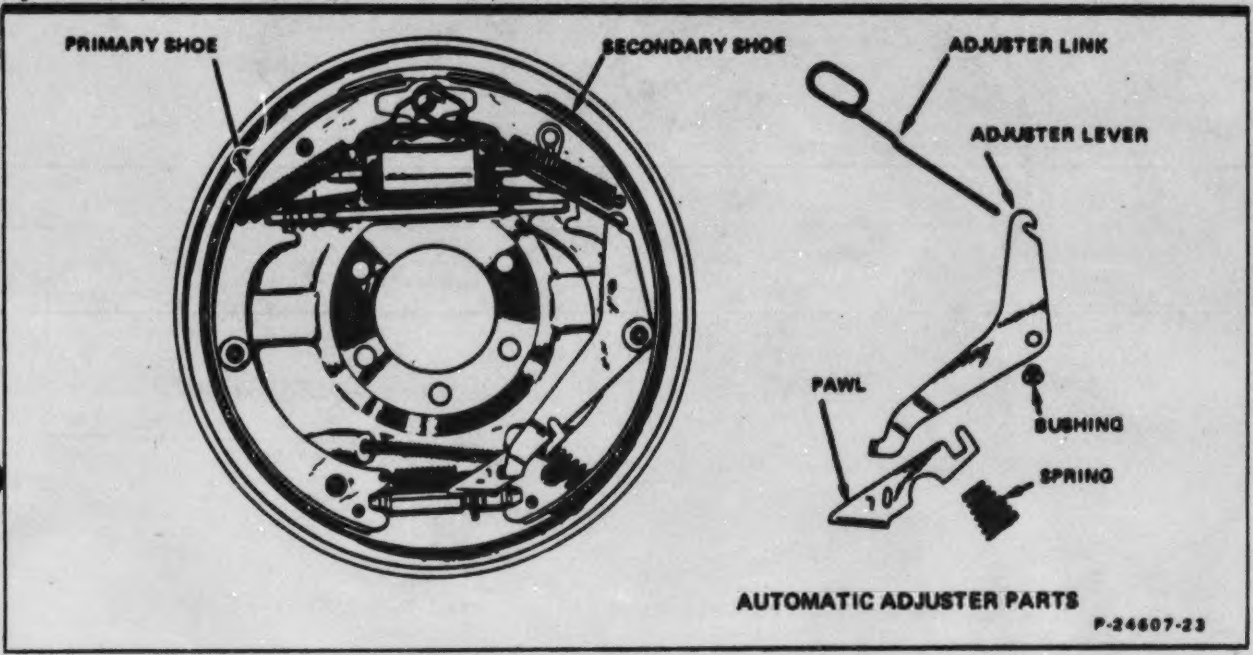

PRIMARY SHOE
SECONDARY SHOE
ADJUSTER LINK
ADJUSTER LEVER
PAWL
BUSHING
SPRING
AUTOMATIC ADJUSTER PARTS
P-24607-23

Figure 11. Duo-Servo Brake With Delco-Moraine Automatic Adjuster - Left Rear Shown (Lever and Pawl)

DISASSEMBLY

The disassembly procedures for this brake (Figure 11) are generally the same as those for the Bendix Duo-Servo Brake except as follows:

Remove shoes, adjusting screw and lower shoe-to-shoe spring as an assembly. Then overlap anchor end of shoes to reduce spring tension, and remove spring and adjusting screw, from shoes.

RE-ASSEMBLY

Same as Bendix Duo-Servo Brake except as follows:

Pre-assembly shoes, adjusting screw and sho-to-shoe spring prior to installing shoes on backing plate.

Duo-Servo Brake with Wagner Automatic Adjuster

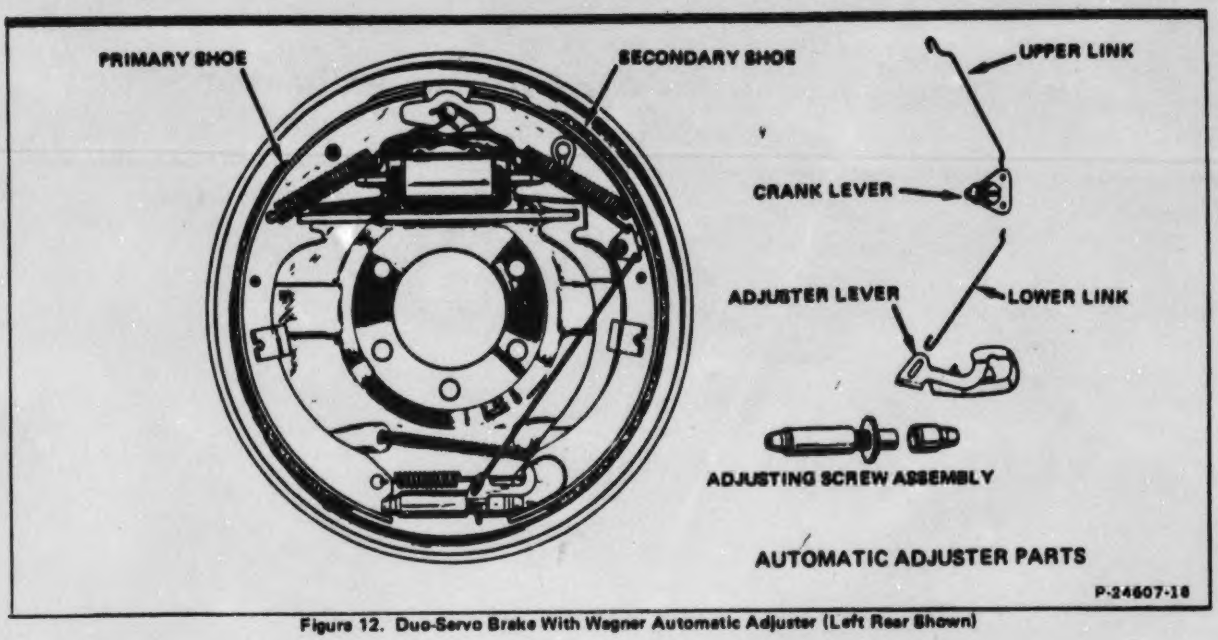

PRIMARY SHOE
SECONDARY SHOE
UPPER LINK
CRANK LEVER
ADJUSTER LEVER
LOWER LINK
ADJUSTING SCREW ASSEMBLY
AUTOMATIC ADJUSTER PARTS
P-24607-18

Figure 12. Duo-Servo Brake With Wagner Automatic Adjuster (Left Rear Shown)

DISASSEMBLY

The disassembly procedures for this brake (Figure 12) are generally the same as those for the Bendix Duo-Servo Brake except as follows:

1. Remove shoes, adjusting screw and lower shoe-to-shoe spring as an assembly. Then overlap anchor end of shoes to reduce spring tension, and remove spring and adjusting screw from shoes.
2. Remove crank lever from secondary shoe web.

RE-ASSEMBLY

Same as Bendix Duo-Servo Brake except as follows:

1. Position crank lever on web of secondary shoe, and secure in place with a self-threading screw.
2. Pre-assemble shoes, adjusting screw and sho-to-shoe spring prior to installing shoes on backing plate.
3. Attach upper automatic adjuster link to anchor pin after both shoe return springs have been connected.

ADJUSTMENT

Same as Bendix Duo-Servo Brake except as follows:

Do not hold adjuster lever away from star wheel when backing off adjusting screw as this may distort lever.

Bendix Non-Servo Brake with Automatic Adjuster

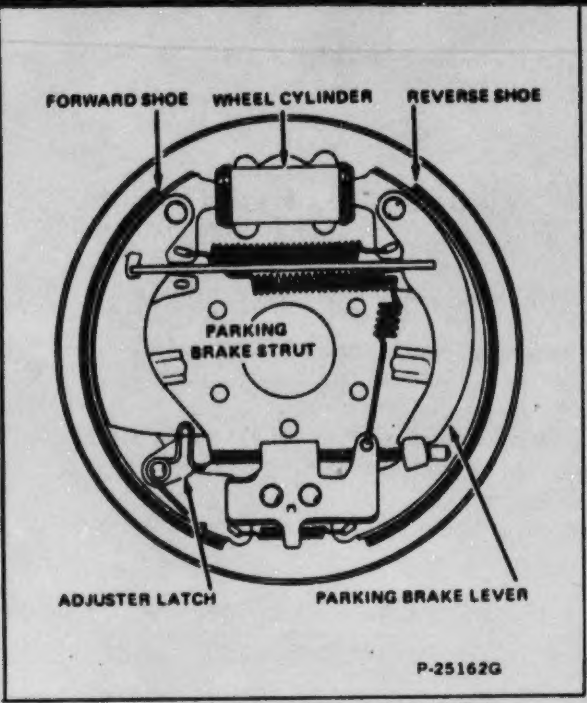

FORWARD SHOE
WHEEL CYLINDER
REVERSE SHOE
PARKING BRAKE STRUT
ADJUSTER LATCH
PARKING BRAKE LEVER
P-25162G

Figure 13. Bendix Non-Servo Brake (Left Rear Shown)

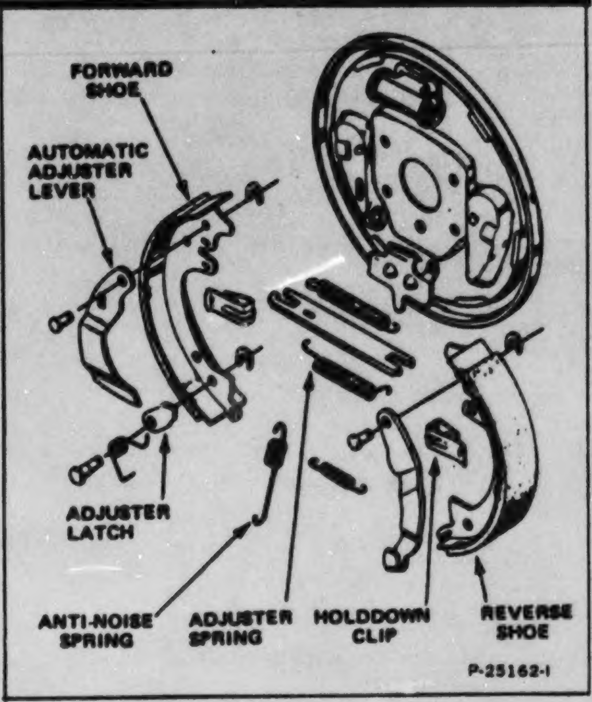

FORWARD SHOE
AUTOMATIC ADJUSTER LEVER
ADJUSTER LATCH
ANTI-NOISE SPRING
ADJUSTER SPRING
HOLDDOWN CLIP
REVERSE SHOE
P-25162-I

Figure 14. Bendix Non-Servo Brake

DISASSEMBLY

1. Be sure that parking brake is released.

2. Remove wheel and drum. If shoes interfere with drum removal, insert screwdriver in access hold (in backing plate), and press down on adjuster latch to permit shoes to retract.

3. Install wheel cylinder clamp. Then unhook adjuster spring from parking brake strut and reverse shoe.

4. Unhook upper shoe-to-shoe spring from shoes, and unhook anti-noise spring from spring bracket.

5. Remove parking brake strut, and disengage shoe webs from flat, clamp-type shoe holddown clips.

6. Unhook lower shoe-to-shoe spring, and remove forward shoe. Disconnect parking brake cable, and then remove reverse shoe.

7. Remove shoe holddown clips from backing plate.

8. Press C-Shaped retainers off of pins, and remove parking brake lever, automatic adjuster lever and adjuster latch.

RE-ASSEMBLY

1. Apply light coat of high temperature lubricant to shoe support points on backing plate, to adjuster lever and latch pins, and to anchor.

2. Assembly levers and latch on shoes with pins and retainers.

NOTE: The reverse shoe, mounted toward rear of car, can be identified by its narrower lining.

3. Lubricate inner surface of shoe holddown clips, and assembly clips on backing plate with short end of clips in slot in plate.

4. Connect cable to parking brake lever, and attach lower sho-to-shoe spring to shoes.

5. Position shoes on backing plate, and slide shoe webs into holddown clips. Be careful not to disengage clips from backing plate.

6. Install parking brake strut with tab on strut engaging slot of adjuster lever.

7. Place upper end of shoe webs against wheel cylinder, and install upper shoe-to-shoe spring. Remove wheel cylinder clamp.

8. Attach automatic adjuster spring to reverse shoe and parking brake strut.

9. Attach anti-noise spring between spring bracket and reverse shoe.

ADJUSTMENT

Make a number of alternate forward and reverse stops applying firm pressure to the brake pedal on each stop to bring shoes to proper adjustment.

Delco-Moraine Non-Servo Brake with Automatic Adjuster

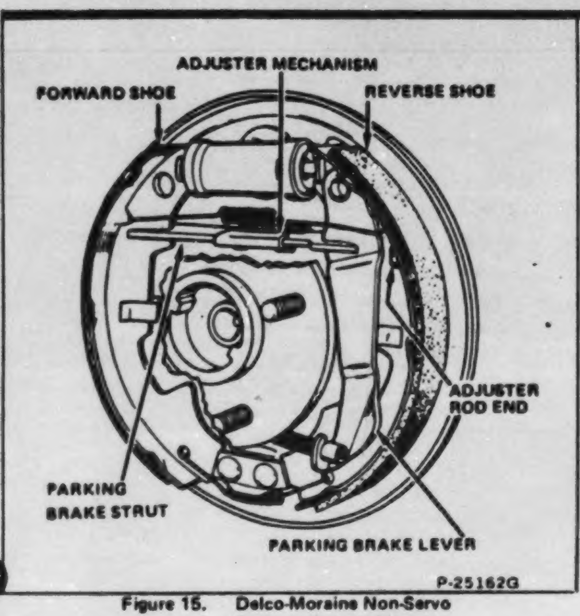

ADJUSTER MECHANISM
FORWARD SHOE
REVERSE SHOE
ADJUSTER ROD END
PARKING BRAKE STRUT
PARKING BRAKE LEVER
P-25162G

Figure 15. Delco-Moraine Non-Servo Brake-Left Rear Shown

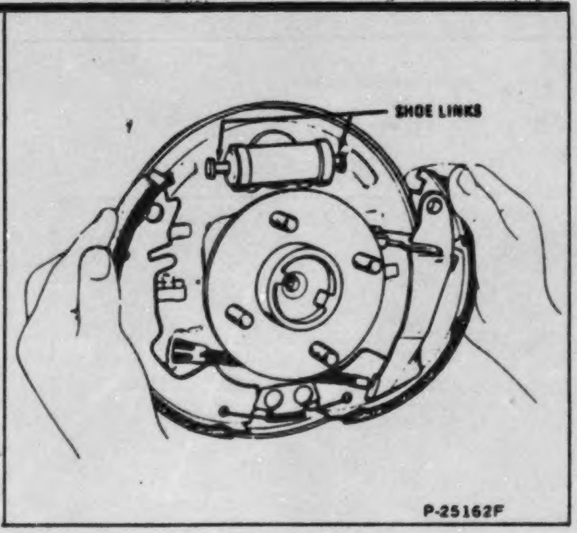

SHOE LINKS
P-25162F

Figure 16. Removing Shoes

DISASSEMBLY

1. Remove wheel and drum.

NOTE: If shoes interfere with drum removal, punch out lanced area in drum. Then insert a screwdriver, and press on end of adjuster rod (Figure 15) to disengage it from trailing shoe web. Be sure to remove any metal particles from inside drum.

2. Adjust nut at parking brake equalizer to remove all tension from parking brake cable.

3. Disconnect cable from parking brake lever.

4. Remove upper shoe-to-shoe spring.

5. Pull shoes from under holddown clips (Figure 16), and remove shoes with strut and adjuster assembly.

6. Separate the shoes, and remove strut and adjuster assembly.

7. Press down on adjuster locks of adjuster assembly, and slide adjuster rod over locks to the position shown below. Note that adjuster lock index hole is about one-half covered by rod assembly.

NOTE: Be careful to avoid damage to adjuster lock tabs. If tabs are damaged, a new parking brake strut and adjuster assembly should be installed.

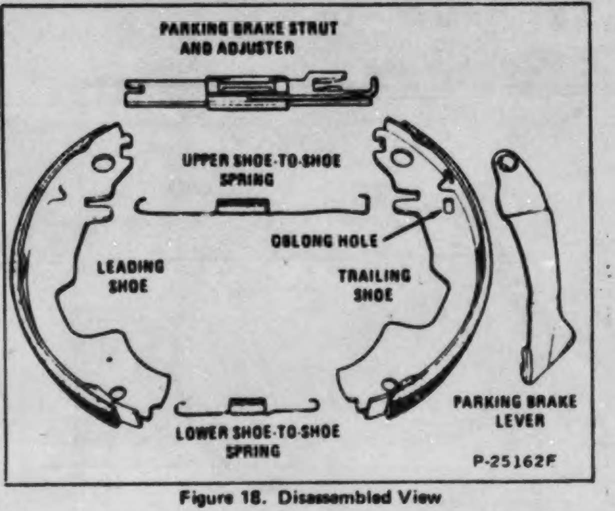

PARKING BRAKE STRUT
AND ADJUSTER
UPPER SHOE-TO-SHOE
SPRING
OBLONG HOLE
LEADING
SHOE
TRAILING
SHOE
PARKING BRAKE
LEVER
LOWER SHOE-TO-SHOE
SPRING
P-25162F

Figure 18. Disassembled View

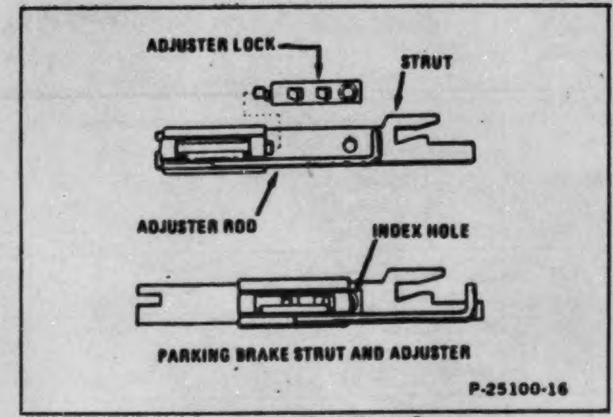

ADJUSTER LOCK
STRUT
ADJUSTER ROD
INDEX HOLE
PARKING BRAKE STRUT AND ADJUSTER
P-25100-16

Figure 17. Adjuster Parts

RE-ASSEMBLY

1. Apply light coat of high temperature lubricant to shoe support points on backing plate.

2. Position parking brake lever on reverse shoe with bushing near top of lever inserted through hole in shoe web.

3. Attach parking brake strut and adjuster assembly to reverse whoe.

NOTE: The reverse shoe web has an oblong hole to accept adjuster rod.

4. Connect lower shoe-to-shoe spring to shoes, and position shoes on backing plate as shown in Figure 16. Be sure shoe webs properly engage wheel cylinder shoe links.

5. Install upper shoe-to-shoe spring. Note that square hook end of spring is connected to trailing shoe.

6. Connect cable to parking brake lever. Be careful not to move adjuster lock from installed position.

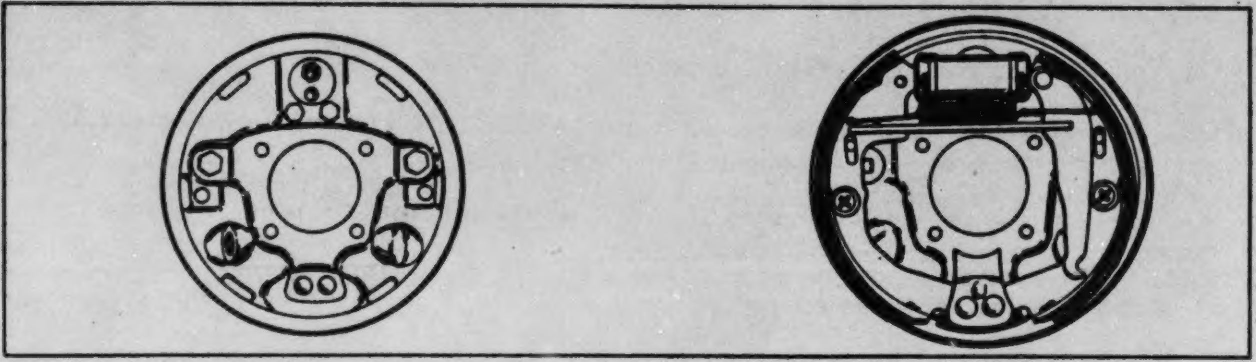
7. Install wheel and drum.

ADJUSTMENT

Adjust nut at parking brake equalizer. Then set and release parking brake three or four times to adjust the brakes.

CAUTION: Be sure that the brake pedal is firm before moving the car.

Chevette Non-Servo Brake with Automatic Cam Adjusters



DISASSEMBLY

1. Check that the parking brake lever is fully released.
2. Remove the brake drum.

NOTE: If shoes must be retracted in order to remove the brake drum, rotate the shoe adjuster cams toward the wheel cylinder.

3. Disconnect parking brake cable from parking brake lever.
4. Remove upper shoe return spring.
5. Remove shoe retainers and holddown springs.
6. Shoes, parking brake lever, and lower shoe return spring can be removed from the backing plate as an assembly.
7. Separate parking brake strut from parking brake lever.

CLEANING AND INSPECTION

Check shoe adjuster cams. If severely worn, loose, or frozen; both the backing plate and adjuster assembly should be replaced.

NOTE: 29-44 in lbs. torque is required to rotate adjuster cams.

RE-ASSEMBLY

1. Connect parking brake lever to the reverse shoe.
2. Hook lower return spring to both shoes.
3. Position forward and reverse shoe on the backing plate and secure forward shoe with holddown spring and retainer.
4. Secure the reverse shoe once the parking brake strut has been positioned.

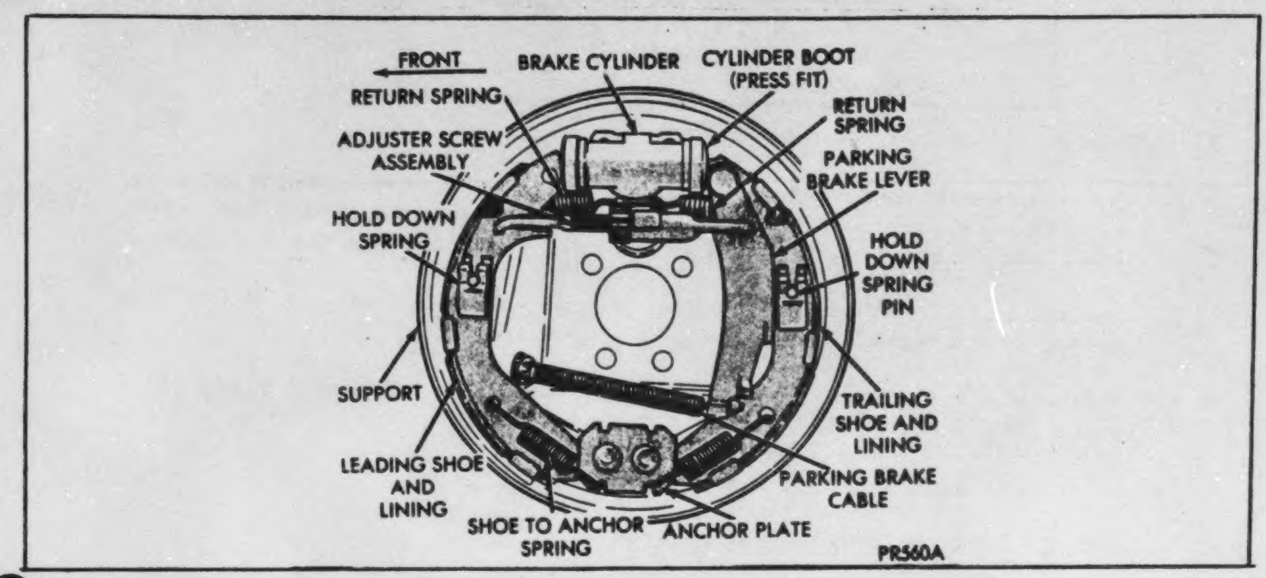
NOTE: Make sure that the pin of each cam adjuster is aligned in the adjusting slot of both shoes.

5. Hook upper shoe return spring in position making sure that both shoes butt up against the wheel cylinder pistons.
6. Connect parking brake cable to parking brake lever.
7. Install brake drum and wheel. Shoe adjustment is obtained by applying brake pedal repeatedly until firm pedal is acquired.

CAUTION: Be sure that the brake pedal is firm before moving the car.

8. Road test vehicle.

DODGE OMNI, PLYMOUTH HORIZON NON-SERVO MANUAL ADJUSTING BRAKE


FRONT
BRAKE CYLINDER
CYLINDER BOOT (PRESS FIT)
RETURN SPRING
RETURN SPRING
ADJUSTER SCREW ASSEMBLY
PARKING BRAKE LEVER
HOLD DOWN SPRING
HOLD DOWN SPRING PIN
SUPPORT
TRAILING SHOE AND LINING
LEADING SHOE AND LINING
PARKING BRAKE CABLE
SHOE TO ANCHOR SPRING
ANCHOR PLATE
PR560A

DISASSEMBLY

1. Remove plug from brake adjusting hole. Insert thin blade screwdriver into hole. Release brake shoes by moving UP on left side or DOWN on right side.

2. Remove grease cap, cotter pin, lock nut and washer. Remove brake drum and bearing assembly.

3. Remove parking brake cable from lever.

4. Remove shoe to lower anchor springs.

5. Remove adjuster screw assembly by spreading shoes apart. Adjuster nut must be fully backed off.

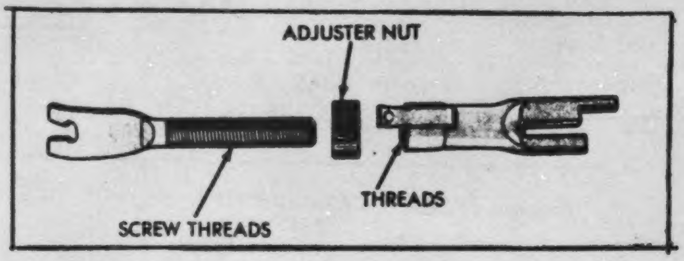
6. Remove shoe holddown springs and pins.

7. Remove shoes. (On trailing shoe, raise parking brake lever.) Pull lower ends of shoes out from lower anchor -- pivot shoe toward center to release return spring tension -- disengage spring and shoe.

CLEANING AND INSPECTION

Inspect adjuster screw assembly for free operation. Lubricate threads.

NOTE: This is a non-automatic (manual) adjuster



RE-ASSEMBLY

1. Install leading shoe return spring in position on shoe. Position shoe against wheel cylinder--hooking return spring into backing plate. Pull lower end of shoe toward front of vehicle and hook into lower anchor.

2. Install trailing shoe in a similar manner pulling lower end of the shoe toward rear of vehicle to hook into lower anchor.

3. Spread shoes and install adjuster screw assembly. Be sure forked end enters the leading shoe with the curved tines down.

4. Insert holddown pins and install springs.

5. Install shoe to lower anchor springs.

6. Compress parking brake cable housing spring slightly to expose cable, then slide into position on parking brake lever.

7. Install brake drum bearing assembly onto spindle. Install washer and nut.

8. Adjust wheel bearing to specifications. Tighten adjusting nut to 31-38 N.m (240-300 in. lbs.) while rotating wheel.

   Back off adjusting nut with wrench to completely release bearing preload. Finger tighten adjusting nut.

   Position nut lock with one pair of slots in line with cotter pin hole. Install cotter pin. The end play should be .003-.076 mm (.0001-.003 in.). Clean and install grease cap.

9. Install wheel and tire assembly.

ADJUSTMENT

This is manually adjusted brake assembly.

1. Release parking brake and back off cable adjustment so there is slack in the line.

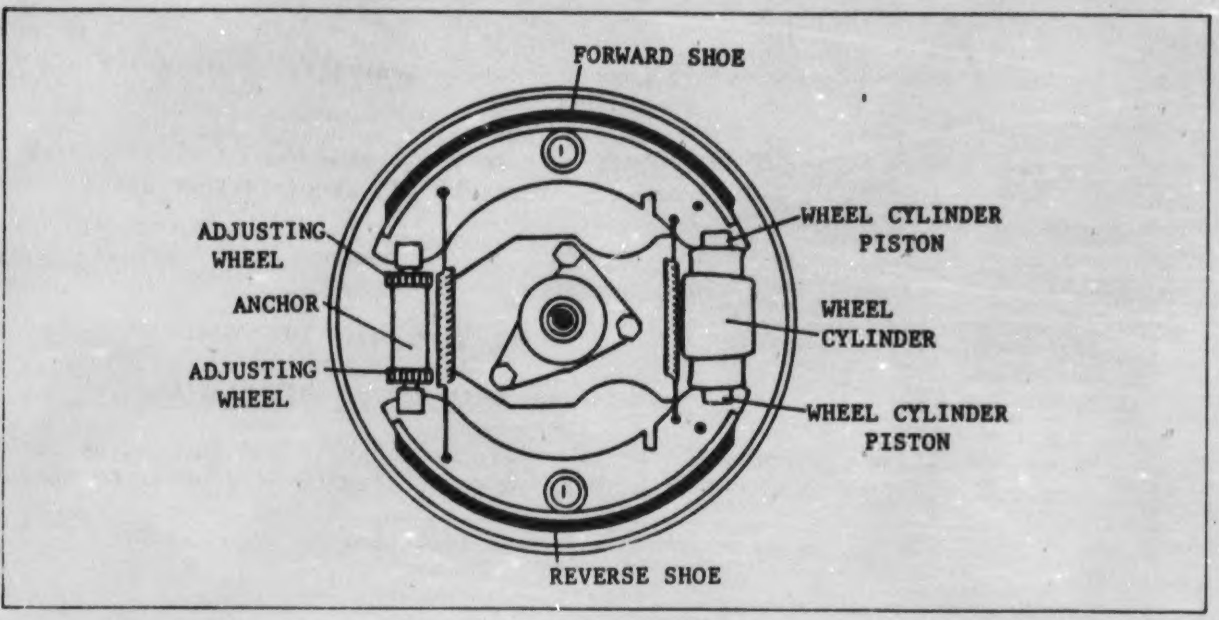
2. Insert narrow screwdriver into adjusting nut hole. Move handle DOWN on left side or UP on right side until brakes are locked.

3. Back off 10 clicks for proper brake adjustment.

4. Install adjusting hole covers in backing plate.

5. Adjust parking brake.

VOLKSWAGEN BRAKES


FORWARD SHOE
ADJUSTING WHEEL
ANCHOR
ADJUSTING WHEEL
WHEEL CYLINDER PISTON
WHEEL CYLINDER
WHEEL CYLINDER PISTON
REVERSE SHOE

DISASSEMBLY

NOTE: The cotter pin for the speedometer cable must be removed prior to removing the hub cap on the left front wheel.

1. Remove wheel, hub cap if front wheel and drum.
2. Remove shoe holddown cups, springs and pins.
3. Disconnect parking brake cable on rear brakes.
4. Remove shoe return springs and remove shoes from backing plate. Remove parking brake strut and lever on rear brakes.

NOTE: After a rear brake drum is removed, inspect the outer grease seal for leakage. If seal is leaking, it must be replaced.

RE-ASSEMBLY

1. On rear brakes, attach parking brake lever to new shoe.
2. Be sure slots in adjusting screws are positioned properly.

3. Install shoes with parking brake strut slot near sheel cylinder. Install shoe return springs.

4. Install shoe holddown pins, springs and cups. Centralize shoes prior to installing drum.

NOTE: On rear brakes, tighten exle shaft nuts to 215 ft-lbs. and install cotter pin. If cotter pin hole is not clear, nut should be tightened further until cotter pin can be inserted.

ADJUSTMENT

1. Depress brake pedal several times to centralize shoes in drums.
2. Turn wheel until hole in drum is in line with one of adjusting wheels.
3. Insert adjusting tool or small screwdriver through hole and turn adjusting wheel to expand shoes until light drag is noted when turning wheel by hand.
4. Back off adjusting wheel 3 or 4 teeth to allow wheel to turn freely.
5. Repeat steps 2, 3 and 4 at other adjusting wheel on same brake.
6. Repeat steps 2, 3, 4 and 5 at other wheel brakes.

Brakes - Drum Brakes

No. C-4 Brake Parts - Inspection and Service
C-5 Drum Brake Repair and Service

Worksheet # 2
Page 1

Name ______________________ **Date** ____________ **Grade** ________

Directions: Complete the following checklist while performing a drum brake overhaul. Note that some sections require an instructor check. You should have this check made before continuing. The last page of this worksheet includes a brake diagram which should be completed to help you remember the correct position of parts.

________ 1. Raise car with jack and support with jack stands.

________ 2. Inspect hydraulic system for leaks and deteriorated lines and hoses.

Condition of: Hoses ______________________

Lines ______________________

Master Cylinder ______________________

Location of Leaks ______________________

____

________ 3. Remove wheels and brake drums. Set front wheel bearings aside for later inspection and service. Vacuum dust.

________ 4. Inspect and measure brake drums

Drum visual condition ______________________

____

Drum size (measured) ______________________

(specified) ______________________

Drum wear (difference) ______________________

INSTRUCTOR CHECK: ______________________

BEFORE DISASSEMBLY: Diagram the parts location for the type of brake you are working on. A blank diagram is located on the last page.

__________ 5. Remove brake shoes and hardware. Keep parts together but separate from the other wheel brake assemblies.

__________ 6. Disassemble, inspect, rebuild or replace wheel cylinders.

INSTRUCTOR CHECK: ____________________

__________ 7. Clean, inspect, service, and lubricate hardware.

Condition of: Shoes ____________________

Return Springs ____________________

Holddown Springs ____________________

Adjuster Linkage ____________________

Star Wheel ____________________

Parking Brake Links ____________________

Backing Plate ____________________

Lubricate: Backing Plate Pads ____________________

Adjuster Linkage ____________________

Star Wheel ____________________

__________ 8. Assemble brake shoes and hardward to backing plate.

__________ 9. Check against diagram for proper assembly. Check automatic adjuster operation.

INSTRUCTOR CHECK: ____________________________

__________ 10. Make initial adjustment of shoes. (Check method.)

Gauge ____________________________

Drum as gauge ____________________________

__________ 11. Service front wheel bearings __________________
Install brake drums. Adjust wheel bearings to specifications.

__________ 12. Bleed hydraulic system.

__________ 13. Install wheels. Make final adjustment and road test.

CAUTION: Make sure you have a firm pedal before attempting to move car.

INSTRUCTOR FINAL CHECK: ____________________________

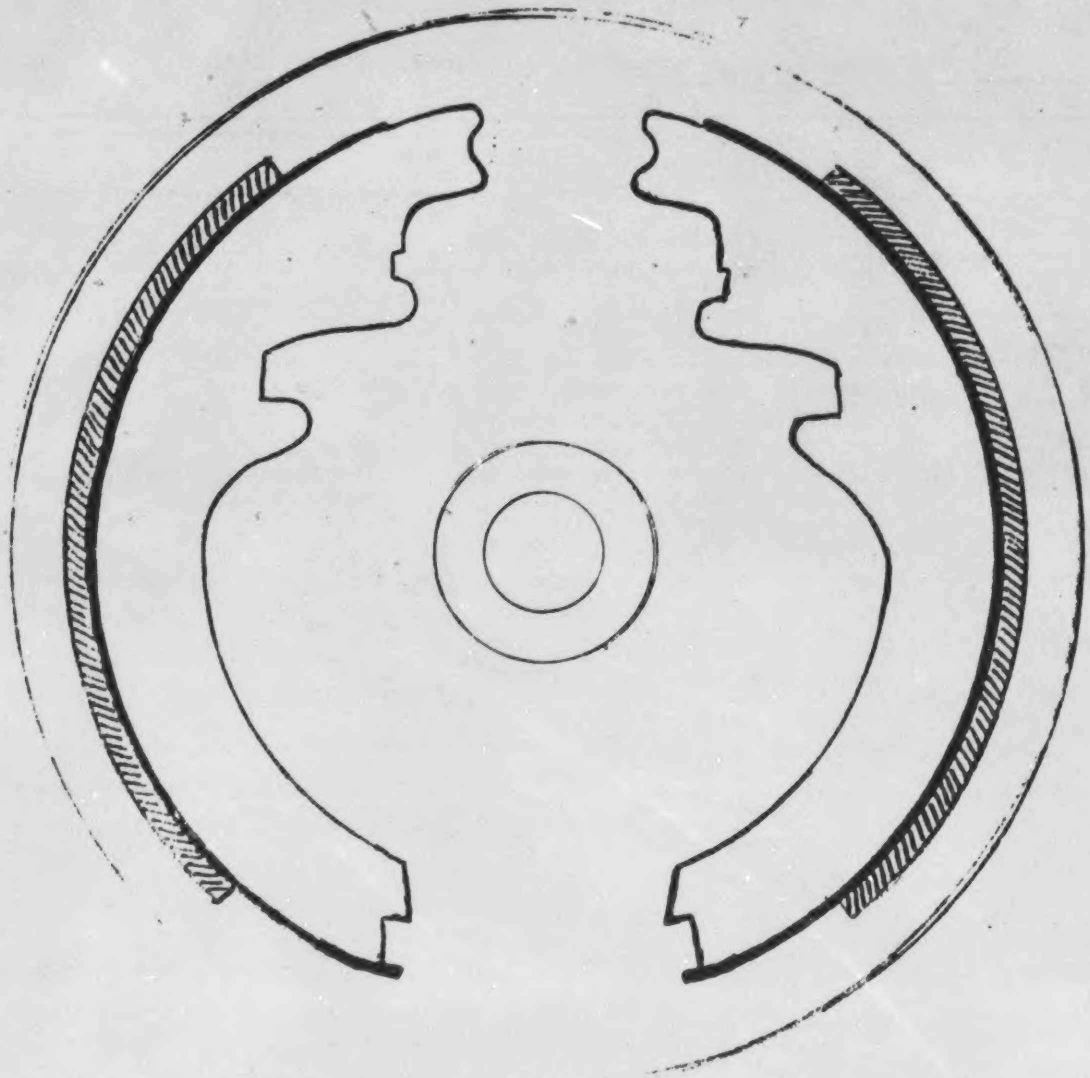
No. C-4 Brake Parts - Inspection
and Service
C-5 Drum Brake Repair and Service

Worksheet # 2
Page 4

Name ________________________________ Date ________________ Grade ________

Using the blank diagram below, carefully sketch in the location of all brake hardware parts. Use labels when necessary to indicate parts. Identify spring colors if they differ from side to side. Indicate location of primary and secondary shoes. Identify the (right or left) side location of the diagram.

Be as exact as possible so that you can use this diagram as an assembly guide.



Brakes - Drum Brakes

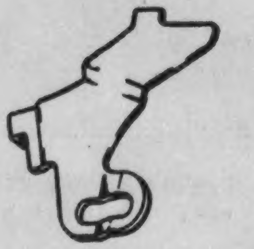
No. C-1 through C-5

Test

Name ____ Date__________ Grade____________

In each of the following questions select the best statement that completes the statement or answers the question.

1.



Mechanic A says that the part illustrated is mounted on the primary brake shoe.

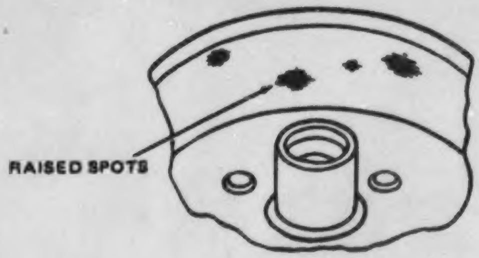
Mechanic B says that the part is mounted on the secondary brake shoe.
Who is right?

a. Mechanic A
b. Mechanic B
c. Both A and B
d. Neither A or B

2. When turning a scored brake drum, the maximum oversize limit for most cases would be

a. 0.060
b. 0.030
c. 0.090
d. 0.110

3.



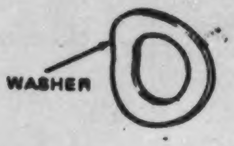
Mechanic A says that the raised surface spots shown above can be removed by turning the drum on a lathe using a carbide tool bit.

Mechanic B says that these spots can be removed by grinding. However, they may reappear when heat is applied. The drum should really be replaced.
Who is right?

a. Mechanic A
b. Mechanic B
c. Both A and B
d. Neither A or B

Name ______________________________ Date ________ Test Grade ____________

4.



The wave washer shown above is designed to:

a. Keep the secondary brake shoe from vibrating
b. Reduce parking brake lever rattle and vibration
c. Keep the primary brake shoe from vibrating
d. Reduce parking brake strut rattle and vibration

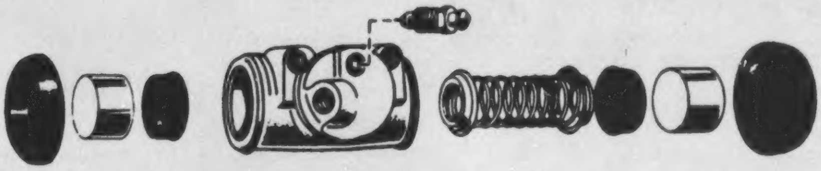
5. A honed wheel cylinder should be checked with a "No-Go" gauge, or inside micrometer and should not exceed ______________ over the original diameter.

a. 0.002
b. 0.005
c. 0.010
d. 0.0005

6. In the two-shoe, single-anchor Bendix brake, which of the following is generally true?

a. The secondary lining is longer than the primary
b. The primary lining is longer than the secondary
c. Both linings are equal in length
d. None of the above.

7.



The above illustration shows the layout of a wheel cylinder prior to assembly. Which item is not being installed correctly?

a. Expander
b. Cup
c. Piston
d. Boot

Test

Name ______________________________ Date ________ Grade __________

8. The drum brake design in wide use today is the

   a. Duo-Servo, fixed anchor
   b. Uni-Servo, fixed anchor
   c. Non-Servo, adjustable anchor
   d. Self-energizing, self-centering, dual anchor.

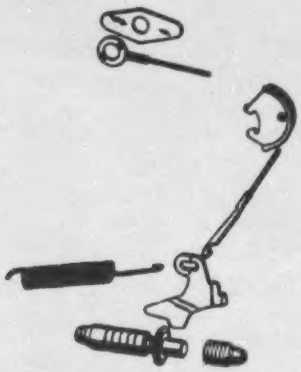
9. Problem: You have assembled a Bendix brake with a cable self-adjusting mechanism. You observe that the adjusting lever is below the center line of the star wheel adjuster. A common cause for this is

   a. The cable guide is not firmly seated against the secondary shoe
   b. The cable guide is not firmly seated against the primary shoe
   c. The cable is too short
   d. Both "a" and "c" above.

10. The rubber strap wrapped around the brake drum during turning on the lathe is to

   a. Cool the drum
   b. Shield operator from flying chips
   c. Prevent drum expansion
   d. Reduce chatter.

11.



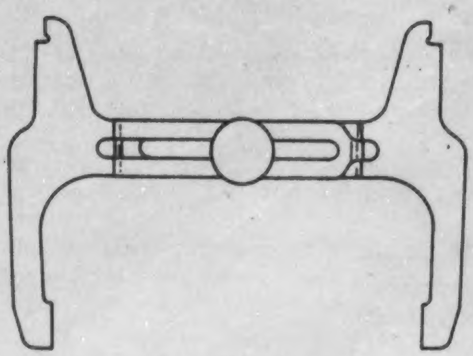
According to the illustration above, these parts would be for the

   a. Front brakes
   b. Rear brakes
   c. Right side brakes
   d. Left side brakes

Test

Name ______________________ Date ________ Grade __________

12.



Mechanic A says that the above tool sets correct lining-to-drum clearance on cars using the Bendix type fixed anchor self-adjusting brake.

Mechanic B says that the above tool sets correct toe and heel clearance. Who is right?

a. Mechanic A
b. Mechanic B
c. Both A and B
d. Neither A or B

13. When a brake drum has been turned 0.050" over OEM size, and the brake shoes are standard, which of the following will apply?

a. The shoes will contact the drum at the ends only
b. The shoes will fit the drum properly
c. The shoes will contact the drum at the center only
d. The shoes should be arc ground only on the ends.

14. To comply with OSHA standards, the arcing of linings should be done only if

a. The mechanic wears safety glasses
b. The mechanic wears a respirator
c. Dust is vacuumed away as it is created
d. All of the above take place.

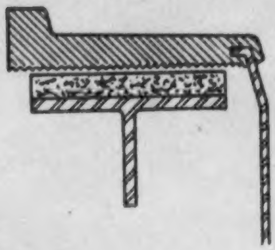
Test

Name ______________________________ Date ________ Grade ____________

15. You are replacing the brake lining on a two-shoe, single-anchor Bendix type brake. Brake drum diameter measures 10.045". When you are grinding the shoe surface, which of the following diameters would you use?

    a. 10.000"
    b. 10.015"
    c. 10.045"
    d. 10.060"

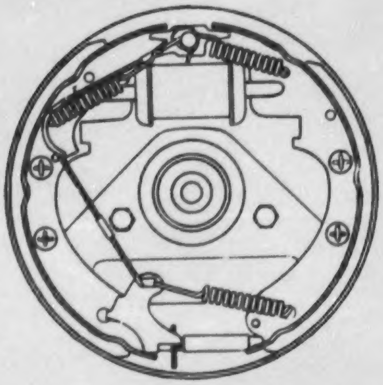
16.



The above pictured drum was turned at too fast a feed. This condition will cause

    a. Low-speed squeal
    b. A snapping noise as brakes are applied
    c. Vibration
    d. Fade.

17.



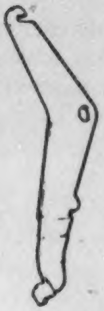
Refer to the above brake assembly illustration. In which direction must the drum turn in order to operate the self-adjusting mechanism?

    a. Clockwise
    b. Counter-clockwise
    c. Either direction
    d. Not enough information given to correctly answer question.

Test

Name ______________________________ **Date**________ **Grade**__________

18.



On the duo-servo brake with a lever type self-adjuster, the above part is mounted on the

I. Secondary brake shoe
II. Primary brake shoe

a. I only
b. II only
c. Either I or II
d. Neither I nor II

19. In a self-energizing duo-servo brake the primary shoe exerts a force on the secondary shoe through the

I. Holddown assembly
II. Retracting springs

a. I only
b. II only
c. Both I and II
d. Neither I nor II

20. In a drum brake, the retracting springs

I. Pull the shoes back from the drum
II. Push the wheel cylinder pistons back in

a. I only
b. II only
c. Both I and II
d. Neither I nor II

Test

Name ________________ **Date** ________ **Grade** ________

21. Which brake part keeps the brake shoes from turning with the drum when the brakes are applied?

    a. Holddown assembly
    b. Star wheel adjuster
    c. Wheel cylinder
    d. Anchor pin

22. Two mechanics are discussing drum brakes. Mechanic A says that anchor pins are usually permanently attached to backing plates. Mechanic B says that rear backing plates are usually bolted to the rear axle housings. Who is right?

    a. A only
    b. B only
    c. Both A and B
    d. Neither A nor B

23. Two mechanics are discussing drum brakes. Mechanic A says that the secondary lining is usually longer than the primary lining. Mechanic B says that the primary lining is usually harder than the secondary lining. Who is right?

    a. A only
    b. B only
    c. Both A and B
    d. Neither A nor B

24. The drum brakes in most common use are called "duo-servo" because they

    a. Use two brake shoes actuated by one wheel cylinder
    b. Are as effective when the car is moving backward as when it is moving forward
    c. Are applied by two wheel cylinder pistons
    d. Have a retracting spring for each shoe.

25. The platforms, or bosses, on the backing plates support the

    a. Brake shoes
    b. Star wheel adjuster
    c. Retracting springs
    d. Holddown springs.

Test

Name ______________________________ Date ________ Grade __________

26. The brake shoe retracting springs are part of the

    I. Mechanical system
    II. Hydraulic system

    a. I only
    b. II only
    c. Both I and II
    d. Neither I nor II

27. To compensate for lining wear, most drum brakes are fitted with

    a. Anchor pins
    b. Star wheel adjusters
    c. Holddown springs
    d. Retracting springs.

28. For a car to have a high brake pedal, its brake lining must be held close to the

    a. Backing plate
    b. Anchor pin
    c. Wheel cylinder
    d. Brake Drum

29. On cars fitted with self-adjusting brakes, the star wheel is prevented from turning backward by the

    a. Adjuster lever
    b. Holddown spring
    c. Cable guide
    d. Anchor pin

30. On cars fitted with self-adjusting brakes of the cable or lever type, the self-adjuster

    I. Operates after a reverse stop
    II. Parts are mounted on the secondary shoe

    a. I only
    b. II only
    c. Both I and II
    d. Neither I nor II

Test

Name ______________________________ Date ________ Grade __________

31. Access slots in a brake drum should be fitted with a

    I. Metal dust cover
    II. Rubber dust cover

    a. I only
    b. II only
    c. I and II
    d. Neither I nor II

32. When you are installing brake shoes, the sequence for installing the springs is as follows

    a. Primary spring, secondary spring, holddown springs
    b. Secondary spring, holddown springs, primary spring
    c. Holddown springs, primary spring, secondary spring
    d. Primary spring, holddown springs, secondary spring.

33. On brakes fitted with cable-type self-adjusters, the cable guide is held by the

    a. Primary shoe retracting spring
    b. Secondary shoe retracting spring
    c. Primary shoe holddown assembly
    d. Secondary shoe holddown assembly.

34. On self-adjusting brakes, the star wheel adjuster usually

    I. Is positioned so that the star wheel is near the secondary shoe
    II. Has a left-hand thread when used on the right side of a car

    a. I only
    b. II only
    c. Both I and II
    d. Neither I nor II

35. On brakes fitted with lever-type self-adjusters, the adjuster lever is held by the

    a. Primary shoe retracting spring
    b. Secondary shoe retracting spring
    c. Primary shoe holddown assembly
    d. Secondary shoe holddown assembly.

Test

Name ______________________________Date________Grade__________

36. After machining a brake drum, you notice a herringbone pattern on the friction surface. The most probable cause of this pattern is

    a. The use of an improperly fitted radii adapter
    b. An improperly sharpened tool bit
    c. Cutting the drum at high feed speed
    d. Improper drum vibration dampening.

37. When mounting a hubbed drum with bearing races on a drum lathe, you should use

    a. A centering cone and a pair of aligning cups
    b. Taper adapters fitted to the bearing cups
    c. A pair of centering cones fitted to the hub
    d. A taper adapter and a pair of centering cups.

38. The most accurate method of machining floating drums that are used on front hubs is to

    a. Mount the drum on the arbor using a centering cone and a pair of aligning cups
    b. Secure the drum to its hub and mount the assembly as if it were a hubbed drum with bearing cups
    c. Mount the drum on the arbor with taper adapters
    d. Center the drum with a pair of centering cones and mount the assembly with an aligning cup.

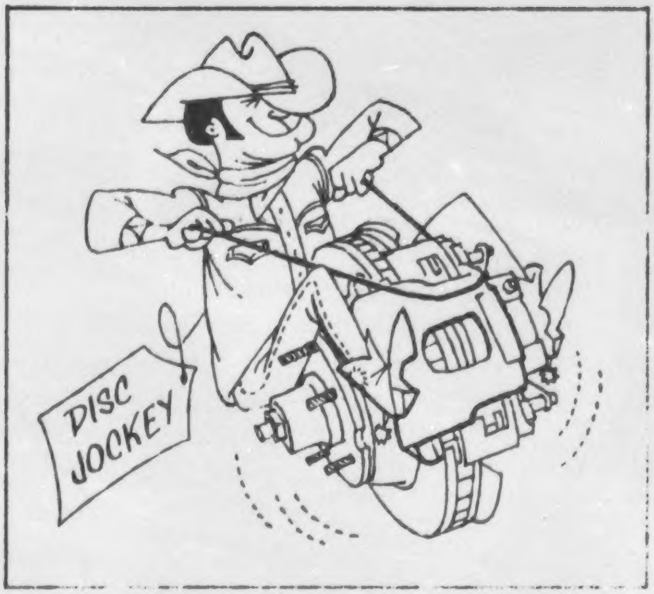
39. Two mechanics are discussing the arc grinding of brake shoes. Mechanic A says arc grinding is necessary to fit the shoes to the new, oversize drum diameter. Mechanic B says arc grinding is necessary to allow a slight shoe flexing to minimize the possibility of brake noise. Who is right.

    a. A only
    b. B only
    c. Both A and B
    d. Neither A nor B

40. Oversize brake lining should be used if drum oversize exceeds

    a. 0.010 in.
    b. 0.020 in.
    c. 0.030 in.
    d. 0.040 in.

DISC BRAKES


DISC JOCKEY

REFERENCE

The texts chosen were selected because they are in current use by the instructors who compiled this manual. You should have a copy of at least one in your shop.

The text books are to be used as references for each exercise in this book. For each exercise you will find a number followed by page numbers. Look up the book number on this list and the page numbers will correspond to the exercise on which you are working. For example, if you find #4. 103-111 in the reference section, you would check this reference list and find that book No. 4 is Auto Mechanics by H. E. Ellinger. In that book, pages 103-111 will apply to the exercise you are working.

	TEXT	AUTHOR	PUBLISHER
1.	Auto Service and Repair 1975	Stockel	Goodheart - Willcox
2.	Auto Mechanics Fundamentals 1974	Stockel	Goodheart - Willcox
3.	Automotive Encyclopedia 1975	Toboldt - Johnson	Goodheart - Willcox
4.	Auto Mechanics 1977 Second Edition	Ellinger	Prentice - Hall
5.	Automotive Mechanics 1970 Sixth Edition	Crouse	McGraw - Hill
6.	The Auto Book 1974	Crouse	McGraw - Hill

Disc Brake Competencies

A. Inspection
    1. Inspect rotor
    2. Inspect pads
    3. Inspect calipers
B. Remove and Replace Components
    1. Remove and replace calipers and hardware
    2. Remove and replace brake pads
    3. Remove and replace rotor
C. Rebuild and Machine Components
    1. Turn rotor
    2. Grind rotor
    3. Rebuild caliper
D. Diagnose Disc Brake System
    1. Diagnose noises
    2. Diagnose abnormal pedal position
    3. Diagnose abnormal fluid level
    4. Diagnose abnormal brake operation

Auto Mechanic
Disc Brake System and Service
No. D-Index

D-1 Safety

D-2 Disc Pad Replacement

D-3 Caliper Rebuild

D-4 Rotor Service

D-5 Disc Brake Specifications

Auto Mechanics

Disc Brake Systems and Service
No.D - Introduction

Disc brakes were first introduced on American production cars in 1965. The 4-piston type disc brake was used on most vehicles unitl 1967, when the single piston type became available. Generally disc brakes are used only on the front wheels with drum brakes on the rear. However some specialty domestic cars, some foreign cars, and now some current popular models have used disc brakes on all four wheels.

The disc brakes used on domestic automobiles are of one of the three basic designs; fixed caliper, floating caliper, or sliding caliper. Floating and sliding calipers are very similar in design, the only difference being that the sliding calipers slide on the machined surfaces, while the floating calipers slide on the specially designed pins or bolts.

Regardless of the design, each disc brake consists of a caliper assembly that includes the pad and the plate assemblies and one or more hydraulic cylinders; and a rotor assembly that is secured to and rotates with the wheel hub. Since its stopping power is derived from the forces perpendicular to the rotor, there is no servo action in its operation. Due to the lack of servo action, the disc brake requires higher hydraulic pressure than a drum brake, for satisfactory operation. To provide the higher pressure, a power booster is used on most vehicles that are equipped with disc brakes.

The following general service procedures apply to all disc brake systems:

1. Jack up the car, and support on stands. Never work under a car supported only by a jack. Work on one wheel at a time to avoid "popping" the pistons out of the other caliper. Keep grease, oil, and brake fluid off of the caliper, rotor, and pad and lining assemblies.
2. Before removing the brake pads check for hydraulic leaks by pressing the brake pedal. Check power brake equipped cars with the engine running. It is normal for the pedal to drop slightly when the engine starts.
3. The floating caliper must always be removed for pad replacement. Fixed calipers may have pads that can be replaced by removing retaining pins or clips without having to lift off the entire caliper.
4. Never allow the caliper assembly to hang with the weight on the brake hose. The caliper should be firmly supported or suspended using a strong piece of wire as shown in Fig. D-1.

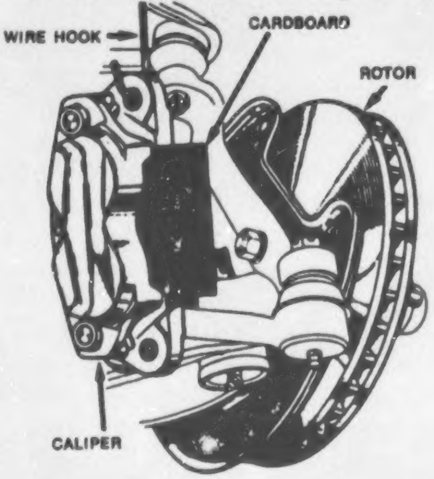


FIGURE D-1—Suspending the Caliper with a Piece of Wire

Disc Brake Systems and Service
No.D - Introduction

5. Before installing new pads, push the caliper pistons back into their bores to make room for new thicker linings. Before pushing the piston back, remove about half of the brake fluid from the master cylinder and discard. If this is not done, the fluid will overflow and spill, possibly damaging the painted surfaces.

CAUTION: Brake lining materials contain asbestos fibers. Avoid creating asbestos dust when servicing the brakes. Breathing asbestos dust may be a potential health hazard.

6. While removing the pads, inspect the areas around the caliper pistons and dust boots for signs of fluid leakage. Also, if there are signs of grooves, scoring, deep scratches, etc., the rotor will have to be machined and the caliper may need rebuildiing. Always replace the anti-rattle clips and other small hardware when installing new brake pads. This will insure getting maximum service out of the new brake pads.
7. After replacing the pads, fill the master cylinder, pump the brake pedal several times to obtain a high, hard pedal. Since disc brakes are self-adjusting by design, there is no need to perform any brake adjustment after abtaining a hard pedal.
8. Disc brake pade wear should be checked at least every 10,000 miles (16,000 km) under normal operating conditions. Under severe conditions, the pad wear should be checked more frequently.

Auto Mechanics
Brakes - Disc Brake Systems and Service
No. D-1 Safety

OBJECTIVE: After completing this unit, the student will be able to safely work on disc brakes and the completed job will be to meet all safety standards.

EXPLANATION: Some of the materials used in brake componets are hazardous to the mechanic and to the finish on the car. The completed work must be with certain specifications, or the car will be a safety hazard on the road.

MATERIALS NEEDED: Safety glasses

TOOLS NEEDED: Pencil

References	Do
#1. Chap. 29, p. 30	# 1. Read references.
#2. pp. 344-356	# 2. Study information sheet.
#3. —	# 3. Complete work sheet No. 1.
#4. --	
#5. pp. 570-571	
#6. --	
#7. --	

Brakes - Disc Brake Systems and Service

No. D-1 Safety

Information Sheet # 1

1. Always use safety stands under a car that is jacked up.
2. Never blow the brake dust off from vehicles with compressed air.
3. Never turn or grind a disc rotor so that it is below the minimum thickness stamped on the rotor.
4. After the rotor has been removed, always replace cotter pin with a new pin.
5. Never allow oil or parts solvent to get into the hydraulic system.
6. Never allow grease, oil, or brake fluid to contaminate brake linings.
7. Never allow brake fluid to become contaminated with oil or moisture.
8. Always pump the brakes so that the pad are seated against the rotor before moving the car.
9. Always use brake fluid with the highest boiling point on disc brake systems.
10. Use extreme caution when road testing a vehicle after the brakes have been worked on.
11. Never use a cracked disc and do not try to weld a cracked drum or disc.
12. Brake fluid is harmful to skin, eyes, and the paint on the car.

Brakes - Disc Brake System and Service

No. D-1 Safety

Test # 1

Name________________________ Date__________ Grade______

TRUE OR FALSE

T F 1. Brake fluid may be replaced with SAE 10W motor oil.

T F 2. Rotors may be turned as much as necessary to give clean, smooth surfaces.

T F 3. Brake fluid may damage the paint on the fender.

T F 4. Any brake fluid is good enough for disc brakes.

T F 5. Cracked Rotors may be welded and then turned.

T F 6. Use clean parts solvent to clean the cylinders in the caliper.

T F 7. After the brake pads have been replaced, you should pump the brakes until you get a good pedal before moving the car.

T F 8. Brake fluid can be harmful to your eyes.

T F 9. After rebuilding caliper cylinders and replacing the pads, the first 2 or 3 brake applications should be high speed panic stops.

T F 10. Use new cotter pins on the spindle nut everytime that the rotor has been removed.

Auto Mechanics
Brakes
No. D-2

OBJECTIVE: After completing this unit the student will be able to properly replace the pads on a fixed caliper disc brake unit.

EXPLANATION: The most common task to be performed on this type of brake system is the replacement of the pads

MATERIALS NEEDED: Safety glasses, brake pads, brake fluid, cotter pin mechanics wire

TOOLS NEEDED: Pliers, torque wrench, ratchet, sockets, suction gun

References		Do	
#1.	Ch. 29 pp. 28-30	#1.	Read references
#2.	pp. 353-355	#2.	Study information sheets
#3.	pp.537-539	#3.	Complete worksheets 1 and 2, 3 or 4.
#4.	pp.447-450		
#5.	pp.524-525		
#6.	pp. 581-583		
#7.	--		
#8.	--		

Brakes - Disc Brake Systems and Service

No. D-2 Disc Pad Replacement

Information Sheet # 1

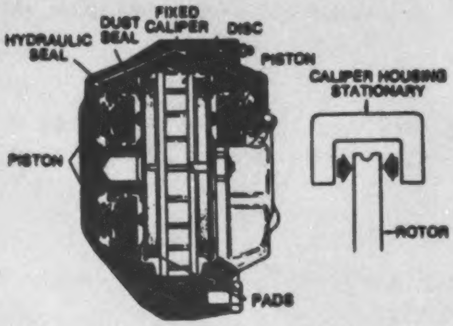


Fig. D-1 —Fixed Caliper Design

FIXED CALIPER DISC BRAKE

This type of brake includes a caliper assembly that is fixed and does not move when the brakes are applied. Most of the fixed calipers used on the domestic cars have four pistons, two in each caliper half. The pistons in both caliper halves force their respective pads against the rotor. Bendix, Budd, Delco-Moraine, and Kelsey-Hayes are the major manufacturers of the four-piston fixed calipers.

BUDD TYPE

The Budd design is very similar to the Bendix design except that it uses insulator pads between the disc brake pads and the piston. The insulators prevent heat transfer from the pads through the pistons and into the brake fluid in the caliper. The splash shield protecting the inboard sied of the rotor is vented to allow the additional air flow for brake cooling. The fixed caliper is composed of an inner and outer housing; two shoes which are each actuated by two pistons and piston springs; piston seals; dust boots; and the retainers. The piston springs hold the pads lightly against the rotors at all times.

BENDIX TYPE

The Bendix design consists mainly of a fixed caliper, four pistons and two floating disc pads. A disassembled view as shown in Fig. D-2.

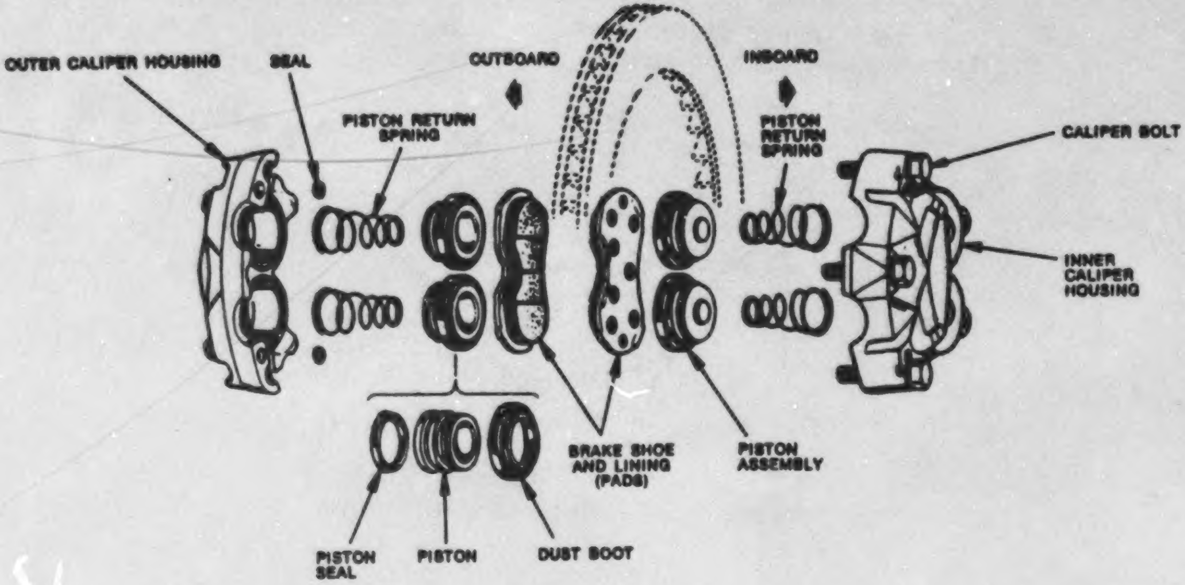

OUTER CALIPER HOUSING
SEAL
OUTBOARD
INBOARD
PISTON RETURN SPRING
PISTON RETURN SPRING
CALIPER BOLT
INNER CALIPER HOUSING
BRAKE SHOE AND LINING (PADS)
PISTON ASSEMBLY
PISTON SEAL
PISTON
DUST BOOT

FIGURE D-2–Bendix Fixed Caliper Four Piston Disc Brake

Brakes - Disc Brake Systems and Service

No. D-2 Disc Pad Replacement

SERVICE PROCEDURE:
Before starting any work, remove about ½ of the brake fluid from the master cylinder reservoir, disc brake side. Discard the fluid and replace the cover.

PAD REMOVAL:

1. Remove the brake pad anti-rattle spring (Fig. D-3).
2. Remove the bolts that hold the brake caliper to the steering knuckle. Do not remove the bolts that hold the caliper halves together.
3. Lift the caliper up and off the rotor.
4. Support the caliper on a sturdy piece of wire so it doesn't hang by the brake hose.
5. Pry between the brake pads to force the pistons back into their boxes. Take care to pry piston from its bore.
6. Lift the pads out of the caliper.

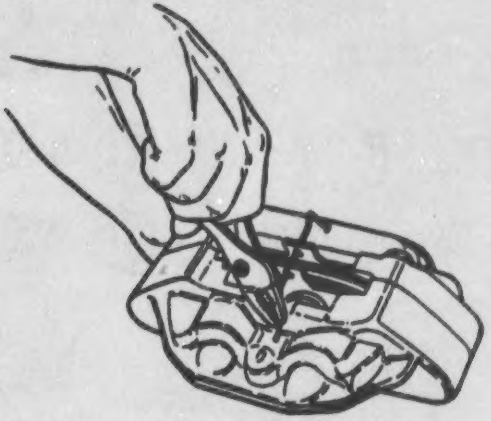


FIGURE D-3—Removing the Anti-Rattle Spring

PAD INSTALLATION:

1. Position the new pads in the caliper.
2. Position the caliper over the rotor.
3. Install the caliper mounting bolts and tighten to specifications
4. Install the anti-rattle spring (Fig. 4).
5. Fill the master cylinder with fresh brake fluid.
6. Obtain a high, hard pedal, refill the master cylinder, and road test the car.

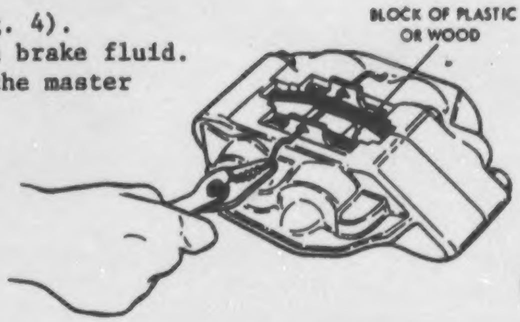


Fig.D-4

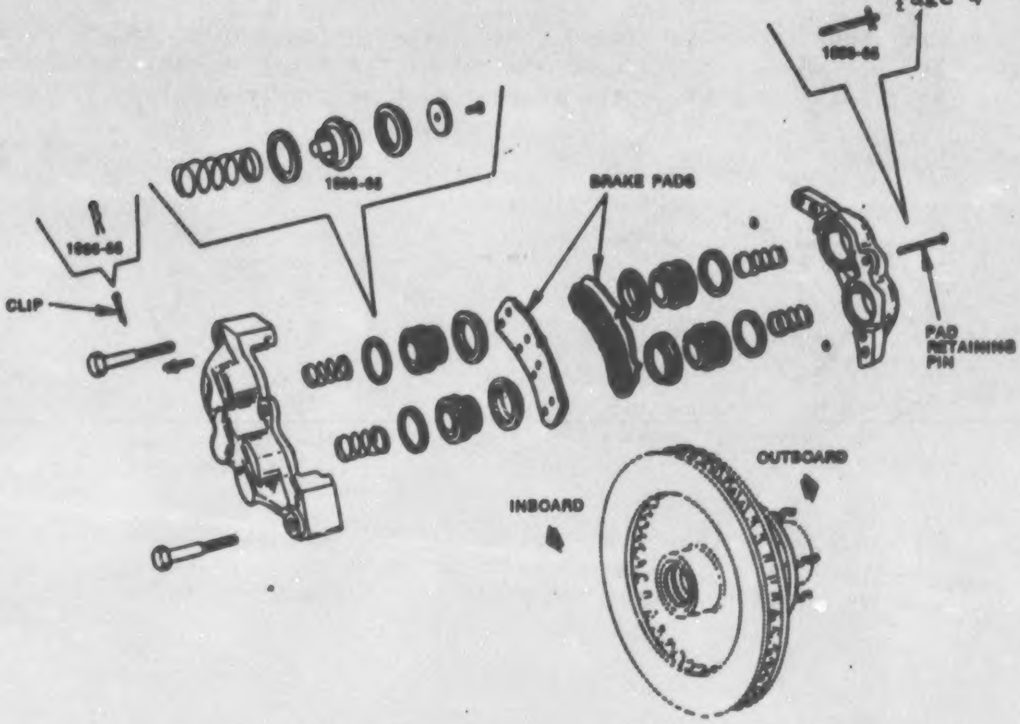


FIGURE D5—Delco-Moraine Fixed Caliper Four Piston Disc Brake

DELCO-MORAINE (GM) TYPE

The brake designed by the Delco-Moraine Division of General Motors is similar to both the Bendix and the Budd setups. The Delco design uses a ventilated rotor attached to the wheel hub. The disc is gripped by two brake pads clamped between the pistons in the caliper (Fig. 5). The piston seals and dust boots help keep the fluid inside the caliper, and dirt and contamination outside the caliper. The Delco design uses piston springs that maintain a light contact between the pads and the rotor. The retaining pins pass through the holes in the pads, holding them in position within the caliper, which is attached to the steering knuckle by means of two mounting bolts. As the brake pedal is depressed, the hydraulic pressure from the master cylinder forces the pistons out of their bores. This action forces the pads against both sides of the rotor, producing the desired braking action.

PAD REMOVAL:

1. Remove the brake pad retaining pins (Fig. 6).

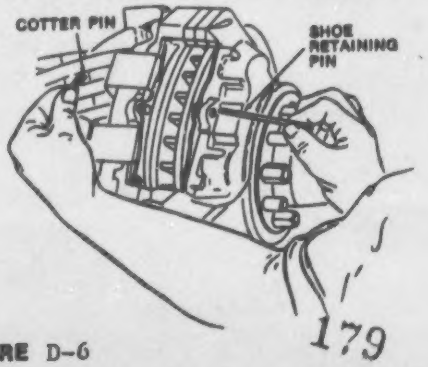


FIGURE D-6

2. Pry the pistons back into their bores (being careful to pry both pistons at once so as not to force one out of its bore) and lift out one pad by tipping it down at the rear, and up at the front (Fig. 7).

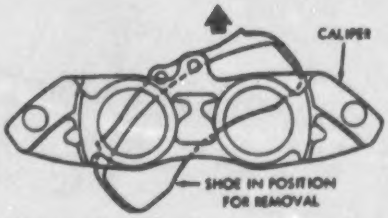


FIGURE D-7—Removing the Shoes (Except Corvette and Camaro Z 28)

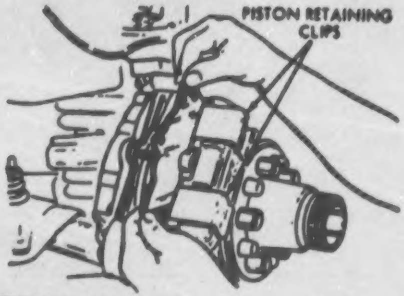


FIGURE D-8—Removing the Shoes—Corvette and Camaro Z 28

3. If the caliper is to be removed for service, disconnect the hydraulic line and plug it. Remove two mounting bolts that attach the caliper to the mounting braket and slide the caliper from the rotor.

PAD INSTALLATION:

1. To replace the caliper, push the pistons back and slip U-shaped retaining clips down over both caliper halves. Locate the caliper over the rotor and install the mounting bolts, tightening to the specified torque.
2. Hold the rear piston in and slide the rear end of the new pad into place, being careful not to force out the front pistion.
3. Push the front piston back into its bore and slide the front of the new pad into position.
4. Change the other pad in the same manner.
5. Reinstall the retaining pin through the caliper holes and through the holes in the pads.

6. Fill the master cylinder with fresh brake fluid.
7. Obtain a high, hard pedal, refill the master cylinder, and road test the car.

On Corvette and Camaro Z 28, make sure that the shoe end with the largest gap between the lining and the edge of the metal backing faces the front of the car (Fig. D-9).

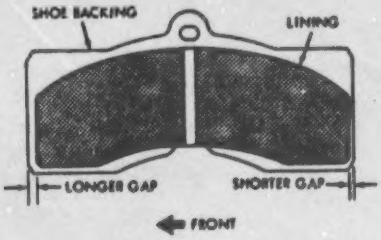

SHOE BACKING
LINING
LONGER GAP
SHORTER GAP
FRONT

FIGURE D9 —Corvette and Camaro Z 28 (4 Wheel Disc) Shoe Position

KELSEY-HAYES TYPE

The brake pads on the Kelsey-Hayes calipers are not held against the rotor by piston springs. Instead they are free to float back, away from the sides of the rotor up to a maximum of 0.005" (0.13 mm). This clearance is possible because the design of the piston seal has a rectangular cross-section and seats in the grooves machined in the calipers bore walls. When the piston is forced toward the rotor, the square-cut seal is twisted slightly. When the pressure behind the piston is released, the seal tries to return to its original shape and position. As it does, it draws the piston back slightly, so that the brake pads are no longer in contact with the rotor. There are no piston springs in this design (Fig. D-10). Anti-rattle clips help prevent unwanted noises and vibrations.

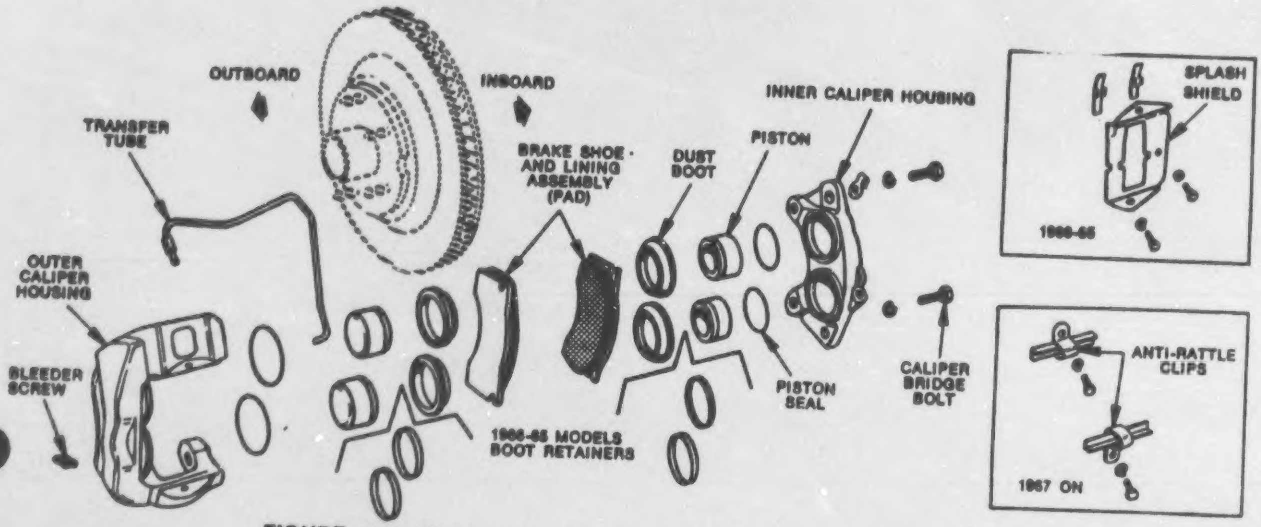

OUTBOARD
INBOARD
TRANSFER TUBE
BRAKE SHOE AND LINING ASSEMBLY (PAD)
DUST BOOT
PISTON
INNER CALIPER HOUSING
SPLASH SHIELD
1965-66
OUTER CALIPER HOUSING
BLEEDER SCREW
PISTON SEAL
CALIPER BRIDGE BOLT
ANTI-RATTLE CLIPS
1965-66 MODELS BOOT RETAINERS
1967 ON

FIGURE D10–Kelsey-Hayes Fixed Caliper Four Piston Disc Brake

PAD REMOVAL:

1. Remove the attaching screws and lift off the splash shield and/or the anti-rattle hardware, or the pad retaining clips.
2. Pry the caliper pistons back into their bores, being careful not to scratch the pistons or bores, and not to cut or tear the dust boots. Pry both pistons at once so as not to force one out of the caliper bore.
3. Provide some clearance by grasping one edge of the shoe and the caliper housing with water pump pliers and work the shoe back and forth (Fig. D-11).

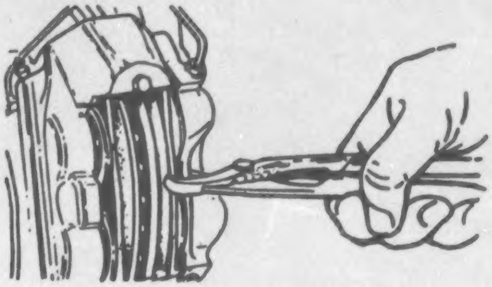


FIGURE D11—Providing the Rotor Clearance by Grasping the Shoe and the Caliper by a Pair of Pliers

4. Using two pairs of pliers, grasp the tabs at each end of shoe and pull the pad straight out of the caliper (Fig. D-12).

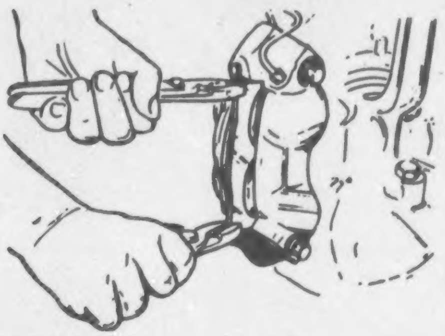


FIGURE D12—Pulling the Pad Out of the Caliper by Two Pairs of Pliers

5. If the caliper is to be removed for overhaul, disconnect the brake tube at the mounting bracket and plug it. Remove the caliper mounting bolts and slide the caliper up and away from the rotor.

PAD INSTALLATION:

1. Position the caliper, and install the mounting bolts, and tighten to specified torque. Check the caliper-to-rotor alignment by measuring the radial clearance of the rotor with a feeler gauge (Fig. D-13). The radial clearance should be 0.090"- .120" (2.29-3.05 mm) over O.D. of the rotor. Then remove the plug and connect the brake tube at the mounting bracket.
2. Slide a new pad into position, making sure the pad ears rest solidly on the bridges of the caliper.
3. After replacing the first pad, repeat this procedure for the other pad.
4. Reinstall the brake pad retaining hardware.
5. Fill the master cylinder with fresh brake fluid.
6. Obtain a high, hard pedal, refill the master cylinder, and road test the car.

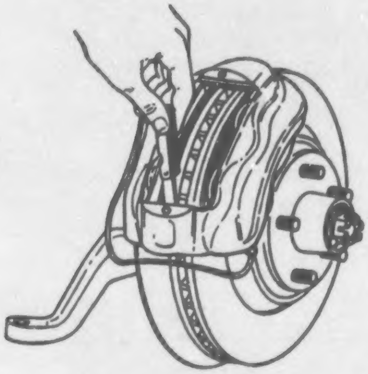


FIGURE D13–Checking the Rotor-to-Caliper Clearance

Brakes - Disc Brake System and Service

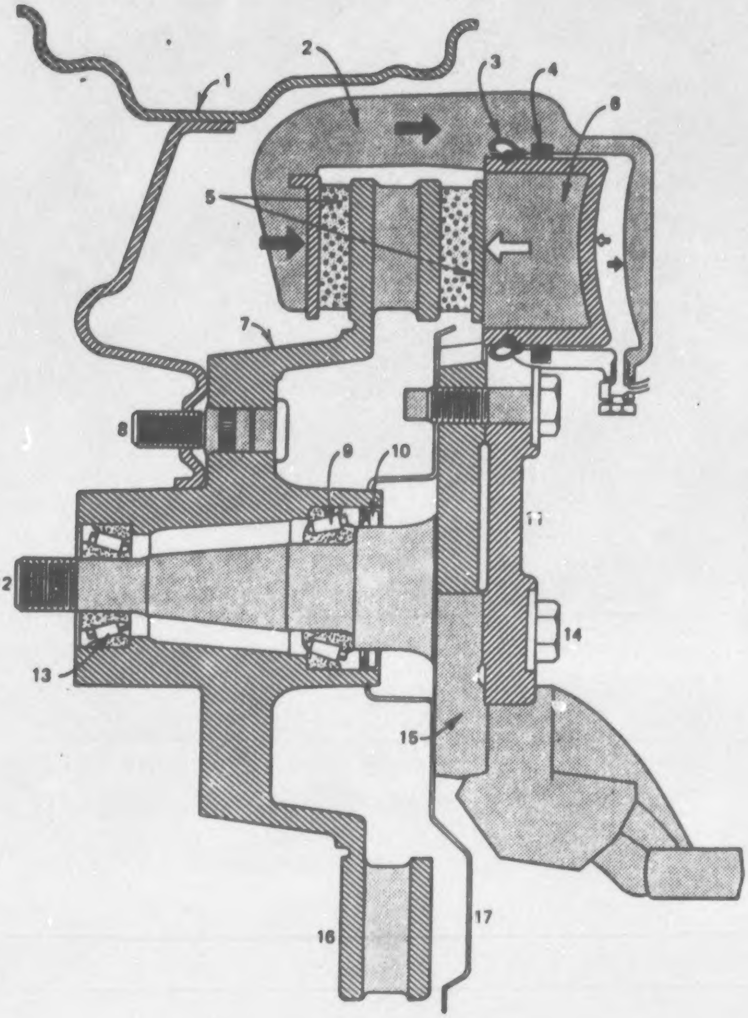
No. D

Worksheet # 1

Name ______________________________ Date ________ Grade __________

IDENTIFY DISC BRAKE COMPONENTS

Directions: Place the number of the part on the drawing in front of the correct part on the part list.



____ Rotor and Hub Assembly

____ Backing Plate

____ Mounting Bolt

____ Wheel

____ Guide Plate

____ Grease Retainer

____ Piston

____ Wheel Stud

____ Caliper

____ Steering Knuckle

____ Shoes and Lining

____ Outer Bearing

____ Splash Shield

____ Reaction Arm

____ Brake Fluid

____ Dust Boot

____ Spindle

____ Piston Seal

____ Adapter or Mount

____ Inner Bearing

________________ Instructor's Initials

Brakes - Disc Brake Systems and Service

No. D-2 Budd-Bendix Type Fixed Caliper

Worksheet # 2

Name_____________________________________Date________________Grade_________

Replace Front Disc Brake Shoes Budd-Bendix

Vehicle Identification Year ________ Make _________ Model__________

Flat Rate Time ________________hrs.

1. Follow the steps in the following general Procedure Outline.

Pad Removal:

1. Remove the brake pad anti-rattle spring.
2. Remove the bolts that hold the brake caliper to the steering knuckle. Do not remove the bolts that hold the caliper halves together.
3. Lift the caliper up and off the rotor.
4. Support the caliper on a sturdy piece of wire so it doesn't hang by the brake hose.
5. Pry between the brake pads to force the pistons back into their bores. Take care to pry back all pistons at once to avoid forcing a piston from its bore.
6. Lift the pads out of the caliper.

Pad Installation:

1. Position the new pads in the caliper.
2. Position the caliper over the rotor.
3. Install the caliper mounting bolts and tighten to specifications.
4. Install the anti-rattle spring.
5. Fill the master cylinder with fresh brake fluid.
6. Obtain a high, hard pedal, refill the master cylinder, and road test the car.

Time on Job ____________hrs. Instructor's Initials ______________

Brakes - Disc Brake System and Service

No. D-2

Worksheet # 3

Name________________________________Date______________Grade________

Replace Front Disc Brake Shoes: Delco-Moraine (G.M.) Fixed Caliper Type

Vehicle Identification Year ______ Make ______ Model ______

Flat Rate Time _______hrs.

1. Read information sheet 1, p. 4.
2. Because there could be variations in the design and mounting of this type of caliper you should also use the manufacturer's service manual to obtain specifications and specific procedures for the car on which you are working.

PROCEDURE OUTLINE

1. Remove the brake and retaining pins.
2. Pry pistons back into their bores
3. Lift out pads.
4. Hold rear piston in and slide the rear end of the new pad into place -- be careful not to force out the front piston.
5. Push the front piston back into its bore and slide the front of the new pad into position.
6. Change other pad in the same way.
7. Reinstall retaining pins.
8. Fill master cylinder with fresh brake fluid.
9. Obtain a high, hard pedal.

Time on Job _______hrs. Instructor's Initials _______

Brakes - Disc Brake System and Service

No. D-2 Kelsey-Hayes Type Fixed Caliper

Worksheet # 4

Name______________________________________Date________________Grade_________

Replace Front Brake Shoes Kelsey-Hayes Fixed Caliper Type

Vehicle Identification Year ______ Make ______ Model ______

Flat Rate Time _______hrs.

1. Follow the steps in the following general "Procedure Outline".

Pad Removal:

1. Remove the attaching screws and lift off the splash shield and/or the anti-rattle hardware, or the pad retaining clips.
2. Pry the caliper pistons back into their bores, being careful not to scratch the pistons or bores, and not to cut or tear the dust boots. Pry both pistons at once so as not to force one out of the caliper bore.
3. Provide some clearance by grasping one edge of the shoe and the caliper housing with water pump pliers and work the shoe back and forth.
4. Using two pairs of pliers, grasp the tabs at each end of shoe and pull the pad straight out of the caliper.
5. If the caliper is to be removed for overhaul, disconnect the brake tube at the mounting bracket and plug it. Remove the caliper mounting bolts and slide the caliper up and away from the rotor.

Pad Installation:

1. Position the caliper, and install the mounting bolts, and tighten to the specified torque. Check the caliper-to-rotor alignment by measuring the radial clearance of the rotor with a feeler gauge. The radial clearance should be 9.090"-0.120" (2.29-3.05 mm) over O.D. of the rotor. Then remove the plug and connect the brake tube at the mounting bracket.
2. Slide a new pad into position, making sure the pad ears rest solidly on the bridges of the caliper.
3. After replacing the first pad, repeat this procedure for the other pad.
4. Reinstall the brake pad retaining hardware.
5. Fill the master cylinder with fresh brake fluid.
6. Obtain a high, hard pedal, refill the master cylinder, and road test the car.

Time on Job _______ hrs. Instructor's Initials _______

Auto Mechanics

No. D-2

OBJECTIVE: After completing this unit, this student will be able to properly replace the brake pads on a floating caliper disc brake unit.

EXPLANATION: Most of the disc brake units that are now in use are the floating caliper type. Routine service requires the replacement of the brake pads.

MATERIALS NEEDED: Safety glasses, brake pads, brake fluid, wheel bearing grease, bearing seal, cotter pins, mechanics wire

TOOLS NEEDED: Pliers, torque wrench, ratchets, suction gun, hammer, screwdriver, ½" and 3/8" Allen wrenches, "C" clamp

References		Do	
#1.	Ch. 29 pp. 28-30	#1.	Read reference
#2.	pp. 353-355	#2.	Study information sheet
#3.	pp. 537-539	#3.	Complete any worksheet 5 to 11
#4.	pp. 447-450		
#5.	pp. 524-525		
#6.	pp. 581-583		
#7.	--		
#8.	--		

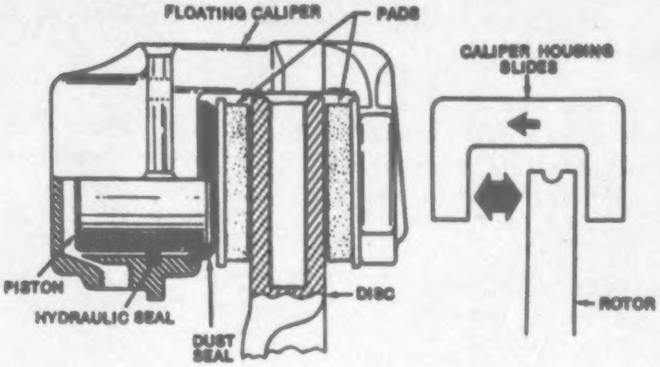

FLOATING CALIPER
PADS
CALIPER HOUSING SLIDES
PISTON
HYDRAULIC SEAL
DUST SEAL
DISC
ROTOR

Fig. D-13 —Floating Caliper Design

FLOATING (OR SLIDING) CALIPER DISC BRAKE

Floating or sliding calipers usually have only one piston, and hydraulic pressure only acts directly on one side of the rotor. But the caliper is free to move, or "float" sideways when the brakes are applied. Some light trucks use a floating caliper disc brake that has two cylinder bores and two pistons. These types of calipers are called either floating or sliding, depending on whether they move on guide pins (floating), or machined surfaces on a caliper support (sliding). Fig. D-13

PAD WEAR PATTERN:

The pads on some floating caliper disc brakes have a tendency to wear in a taper pattern. It is a normal condition and no cause for concern provided that the taper does not exceed 1/8" (3.2 mm) across the face of the pads as shown in Fig. D-14. New pad and plate assemblies should be installed if the taper is more than 1/8" (3.2 mm). When inspecting the disc brake pads, always compare the lining wear of all four pads so as to detect all signs of possible defects.

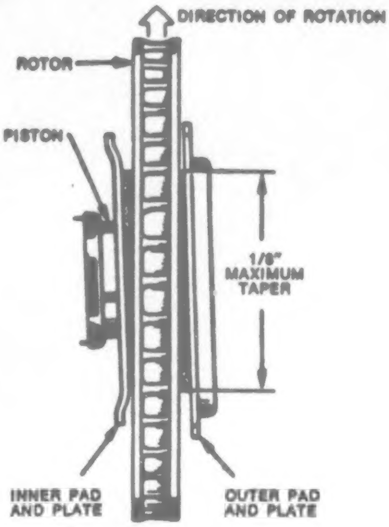

DIRECTION OF ROTATION
ROTOR
PISTON
1/8" MAXIMUM TAPER
INNER PAD AND PLATE
OUTER PAD AND PLATE

FIGURE D14—Pad Wear Pattern

GENERAL MOTORS-DELCO MORAINE
Delco Moraine caliper assembly has two mounting ears at each end of the caliper. Holes are machined in each of the mounting ears. The holes in the inboard ears are larger in diameter than the holes in the outboard ears. Grooves are machined in the inside diameter of the holes in the four ears to accommodate rubber bushings. Sleeves are assembled through the two large holes in the inboard ears. A disassembled view of the GM floating caliper disc brake is shown in Fig. D-15.

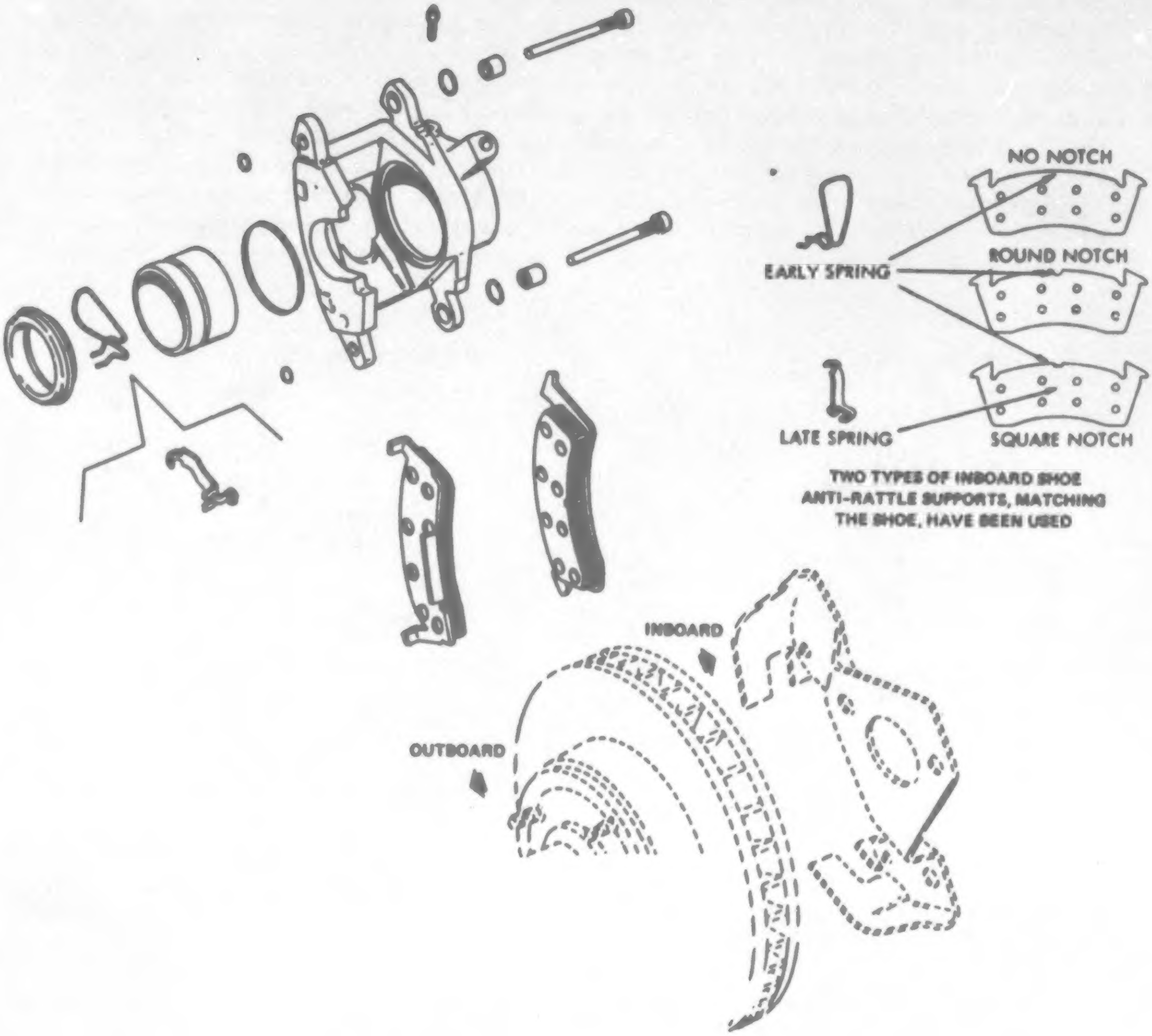

NO NOTCH
EARLY SPRING
ROUND NOTCH
LATE SPRING
SQUARE NOTCH
TWO TYPES OF INBOARD SHOE
ANTI-RATTLE SUPPORTS, MATCHING
THE SHOE, HAVE BEEN USED
INBOARD
OUTBOARD

FIGURE D-15–GM Floating Caliper Disc Brake

SERVICE PROCEDURE:
Before starting any work, remove ½ of the brake fluid from the disc brake side of the reservoir, and discard. Replace the cover.

BRAKE SHOE INSPECTION
Usually, the thickness of the lining remaining on the shoes can be observed when the wheel is removed. Most calipers have an inspection port, or hole, so the inboard shoe can be seen. The outboard shoe should be checked at both its leading and trailing edges. Those are the points where the greatest wear usually occurs. Since the lining is sometimes difficult to see, you should always perform the inspection with the aid of a flashlight or a drop light. Be sure to wear a respirator.

When you check the leading and trailing edges of the shoes, you will often find that the lining is worn unevenly. This is called a tapered wear pattern. In most cases it can be considered normal. You will often find that the lining is worn more on the trailing edge of the shoe than on the leading edge. This is caused by the higher temperatures at the trailing edge of the shoe, as shown in Figure D-17. Sometimes you will find that the lining is worn more on the leading edge of the inner shoe and the trailing edge of the outer shoe, as shown in Figure D-18. This wear pattern is caused by the design and mounting of the caliper, which allows the caliper to twist slightly on brake application. Because of these wear patterns, you should always check the leading and trailing edges of both shoes. One edge could appear safe, but the other edge could be dangerously worn.

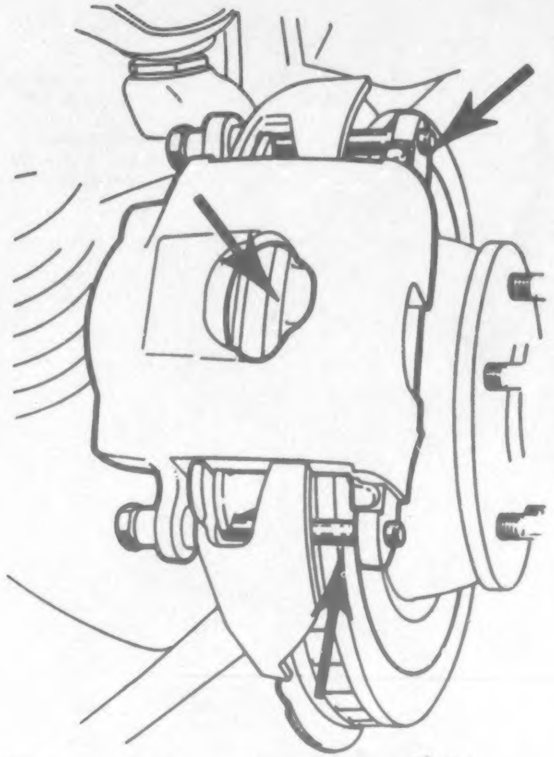


Figure D16 Lining inspection areas (General Motors).

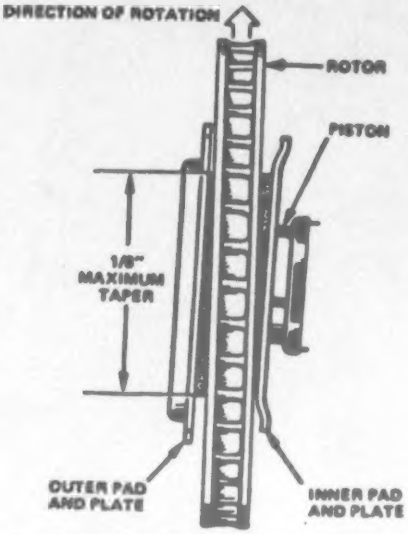


Figure D18 Tapered shoe wear caused by caliper twist during braking (Bendix Automotive Aftermarket Operations).

Not only do brake shoes not always wear evenly, but they do not always wear at the same rate. The type and rate of wear vary considerably with different cars and under different driving conditions. Brake shoes should be replaced when the lining is worn to the minimal thinness allowed by the manufacturer. This specification depends on the type of brakes fitted and on whether bonded or riveted lining is used. Always check an appropriate service manual for this specification. To allow the lining to wear beyond this point could cause rotor damage.

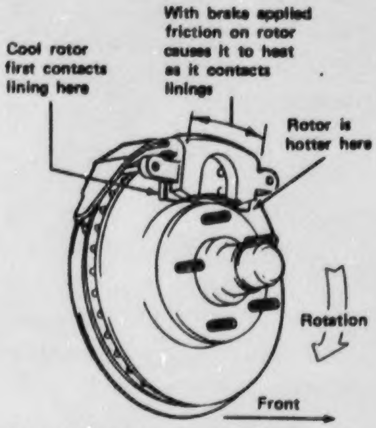

Cool rotor first contacts lining here
With brake applied friction on rotor causes it to heat as it contacts linings
Rotor is hotter here
Rotation
Front

Figure D17 Heat pattern in an operating disc brake (General Motors).

DISASSEMBLY AND REMOVAL:

1. Locate a standard "C" clamp over the caliper with the screw end resting on the outboard shoe. Tighten the clamp until the caliper is pushed out for enough to bottom the piston and provide rotor clearance (Fig. D-19).

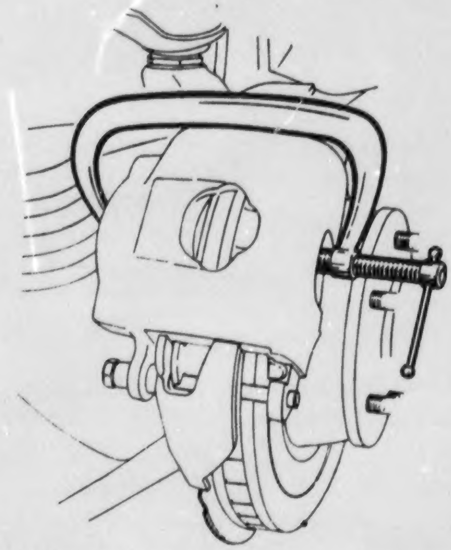


Fig. D-19 Using a C clamp to force the piston into the bore. (*Buick Motor Division of General Motors Corporation*)

2. Remove the "C" clamp. Remove two caliper quide pins which attach it to the support bracket. Lift the caliper off of the rotor (Fig. D-20).

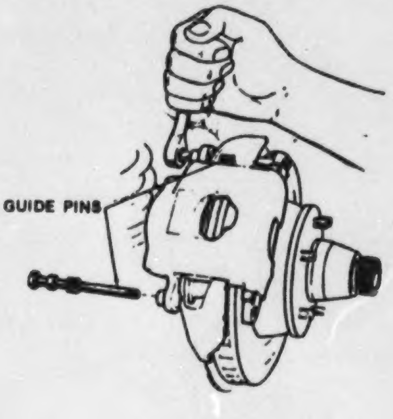


FIGURE D20—Removing the Guide Pins

3. Support the caliper so it doesn't hang by the brake hose.
4. Press the outboard pad inward, then lift it out of the caliper.
5. Press the inboard pad outward, then lift it out of the caliper.
6. Remove and discard four O-ring bushings as shown in Fig. D-21.

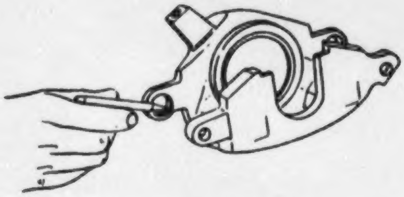


FIGURE D21—Removing the Rubber O-Ring Bushings

ASSEMBLY AND INSTALLATION:

1. Lubricate the O-ring bushings, bushing grooves, sleeves, and the tips of both guide pins with silicon lube. Install the O-ring bushings in the grooves in each of the four caliper ears. Press the sleeves through the O-ring of each inboard ear so that the sleeve end on the shoe side is flush with the machined ear (Fig. D-22)

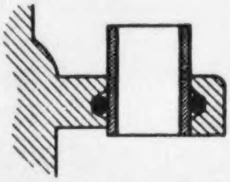


FIGURE D22—New Sleeves (2) Installed in the Inboard Caliper Ears

2. Install a spring wire shoe anti-rattle support in the piston cavity with the tangs facing out at the bottom, or install a clip type support on the inboard shoe backing (Fig. D-23).

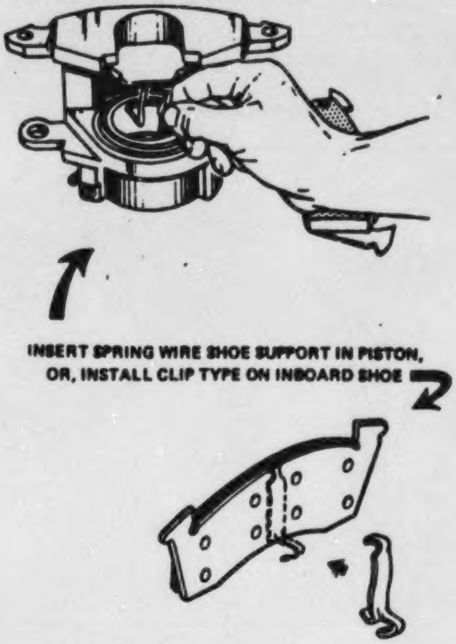

INSERT SPRING WIRE SHOE SUPPORT IN PISTON,
OR, INSTALL CLIP TYPE ON INBOARD SHOE

FIGURE D23—Installing the Aligning Parts

3. Position the inboard pad so the pad contacts the piston and the two support spring ends. Note that the inboard and outboard pads are similar but not interchangeable (Fig. D-24).

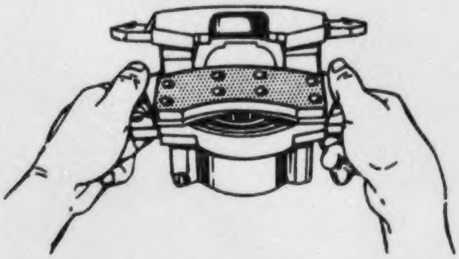


FIGURE D24—Installing the Inboard Shoe

4. Press down on the ears at the top of the inboard pad until the pad lies flat and the spring ends are just inside the lower edge of the pad.
5. Position the outboard pad with the ears toward the positioning pin holes and the tab on the inner edge of the pad resting in the notch in the edge of the caliper. Bend the pad ears if necessary to provide slight interference fit in the caliper (Fig. D-25).

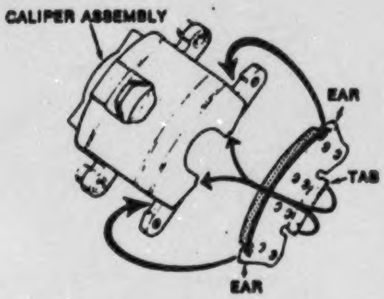

CALIPER ASSEMBLY
EAR
TAB
EAR

FIGURE D25—Installing the Outboard Shoe

6. Press the outboard pad tightly into position and use a pair of pliers to clinch the ears of the outboard pad over the outboard caliper half (Fig. D-26).

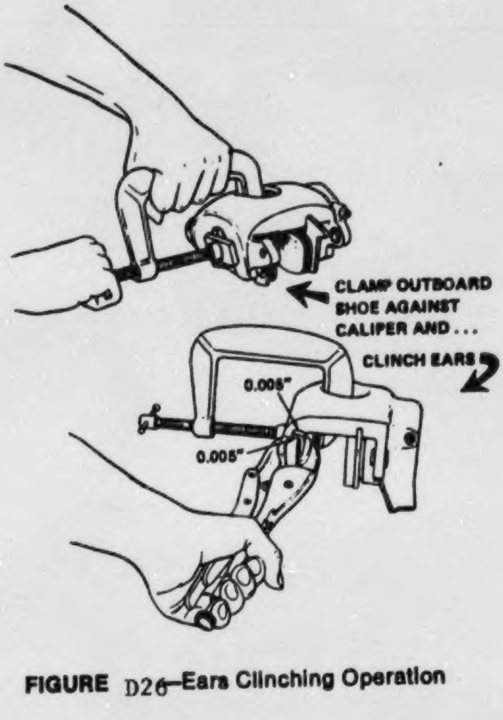

CLAMP OUTBOARD SHOE AGAINST CALIPER AND ...
CLINCH EARS
0.005"
0.005"

FIGURE D26—Ears Clinching Operation

7. Position the caliper over the rotor.
8. Install the caliper guide pins and tighten to the correct specification (Fig. D-27).

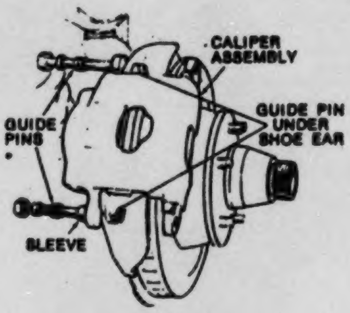

CALIPER ASSEMBLY
GUIDE PIN UNDER SHOE EAR
GUIDE PINS
SLEEVE

FIGURE D27—Installing the Caliper Mounting Bolts (Guide Pins)

9. Fill the master cylinder with fresh brake fluid.
10. Obtain a high, hard pedal, refill the master cylinder, and road test the car.

Chrysler and AMC -- Kelsey-Hayes

This single piston caliper assembly floats through four rubber bushings on two steel quide pins threaded into the adapter. Four machined abutments on the adapter, position and align the caliper, fore and aft. The positioners control the movement of the caliper along with the piston seal and assist in maintaining proper shoe clearance. They also hold the inner bushing in place. A disassembled view of the Chrysler and AMC floating caliper disc brakes (Kelsey-Hayes) is shown in Fig. D-28.

Dodge Ommi, Plymouth Horizon Disc Brake

The single piston caliper assembly floats through rubber bushings on two steel quide pins threaded into the adapter. The steel piston is metric sized (48mm) and smaller than other Chrysler designs. A square cut rubber piston seal is located in a machined groove in the cylinder bore. The adapter is mounted to the steering knuckle by two special nylock bolts. This disc brake caliper is very similar to Fig. D-28.

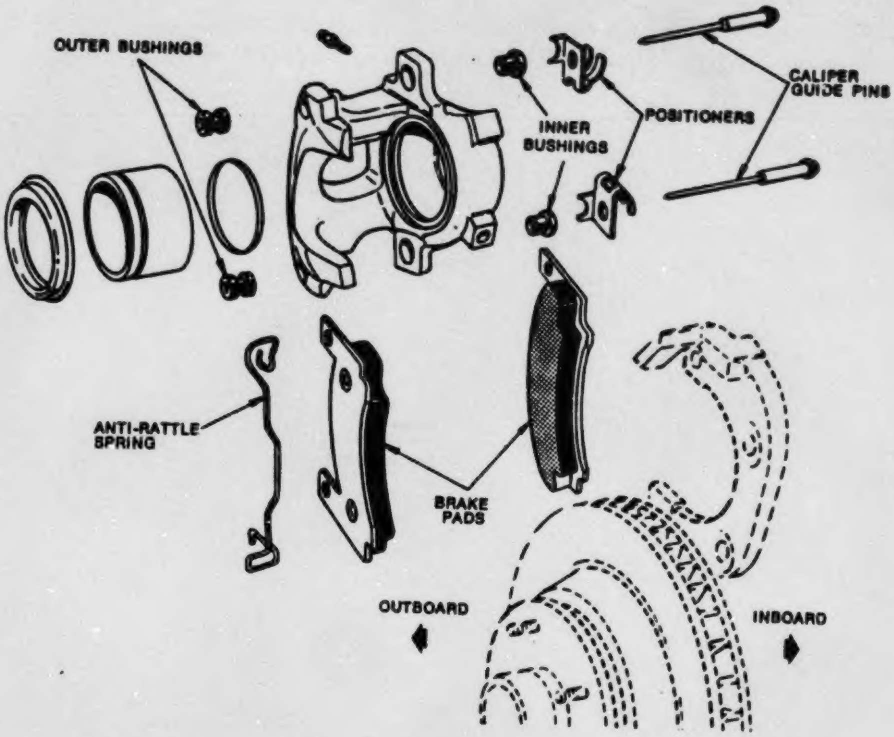


FIGURE D28—Chrysler and AMC Floating Caliper Disc Brake

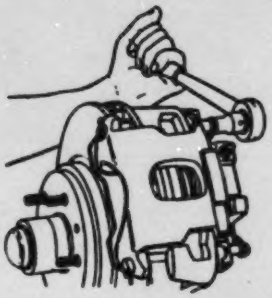


FIGURE D29—Removing the Guide Pins

Disassembly and Removal:

1. Remove the caliper guide pins, the positioners and the anti-rattle spring (Fig. D-29).
2. Lift the caliper off of the rotor (Fig. D-30).

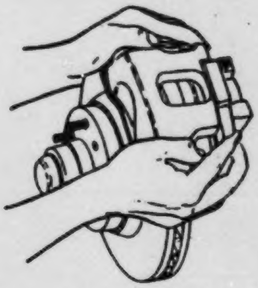


FIGURE D30—Lifting Off the Caliper

3. Support the caliper so it doesn't hang by the brake hose.
4. Pry the piston back into its bore, being careful not to scratch the piston or bore, and not to cut or tear the dust boots.
5. Lift the brake pads out of the caliper.
6. Remove and discard four bushings as shown in Fig. D-31.

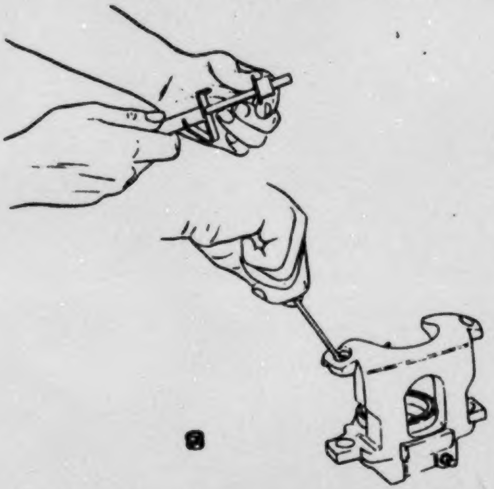


FIGURE D31—Removing the Bushings

Assembly and Installation:

1. Clean and lubricate (with silicon lubricant) the caliper guide pins and the guide surfaces. Install the new bushings as shown in Fig.D-32

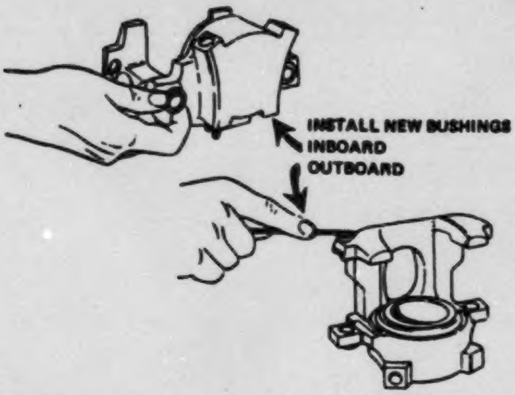


FIGURE D32—New Bushings Installation

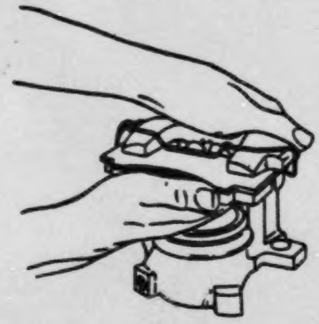


FIGURE D33—Fit the Outboard Shoe Between the Caliper and the Ends of the Anti-Rattle Spring

2. Install the anti-rattle spring and position the new pads in the caliper. The inboard and outboard pads are identical and interchangeable. Fit the outboard shoe (backing) between the caliper and the ends of the anti-rattle spring, as shown in Fig. D-33.
3. Position the caliper on the rotor (Fig. D-34).

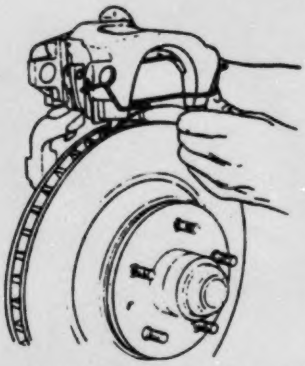


FIGURE D34—Locating the Caliper Over the Adapter and the Rotor

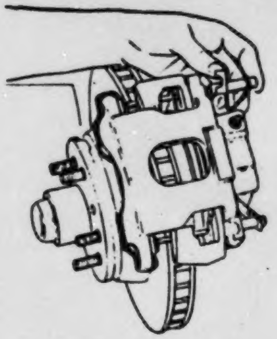


FIGURE D35—Aligning the Positioners

4. Align the guide pin holes of the adapter and the caliper, and install the new positioners over the guide pins, with the open ends facing toward the outside (Fig D-35). Torque the pins to the proper specifications.
5. Fill the master cylinder with fresh fluid.
6. Obtain a high, hard pedal, refill the master cylinder, and road test the car.

Chrysler (Late)--Kelsey Hayes

The disc brake used on some of the Chrysler models such as Imperial, Full Size Models, Intermediates, Challenger, Barracuda, Dart, Valiant (mostly 1977-73 model years) is shown in Fig. D-36.

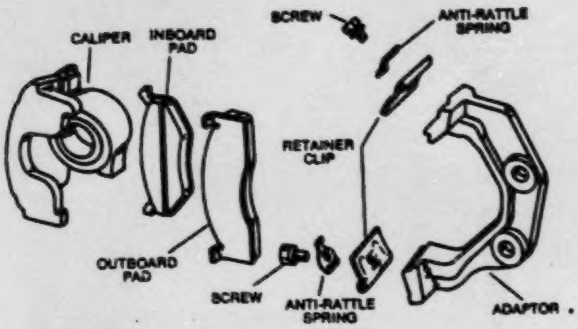


FIGURE D36—Single Piston Sliding Caliper, Kelsey Hayes Disc Brake

These brakes are of the single piston sliding caliper design, manufactured by Kelsey-Hayes. This caliper slides on mechanical surfaces of the caliper and adapter (ways) rather than on guide pins. After removing half of the brake fluid, the following service procedure should be followed:

Disassembly and Removal

1. Remove the caliper retaining clips and the anti-rattle springs.
2. Lift the caliper off of the rotor.
3. Support the caliper so it doesn't hang by the brake hose.
4. Use a large C-clamp to force the piston back into its bore, being careful not to scratch the piston or bore, and not to cut or tear the dust boot.
5. Pry the outboard pad from the caliper.
6. Remove the inboard pad from the adapter.

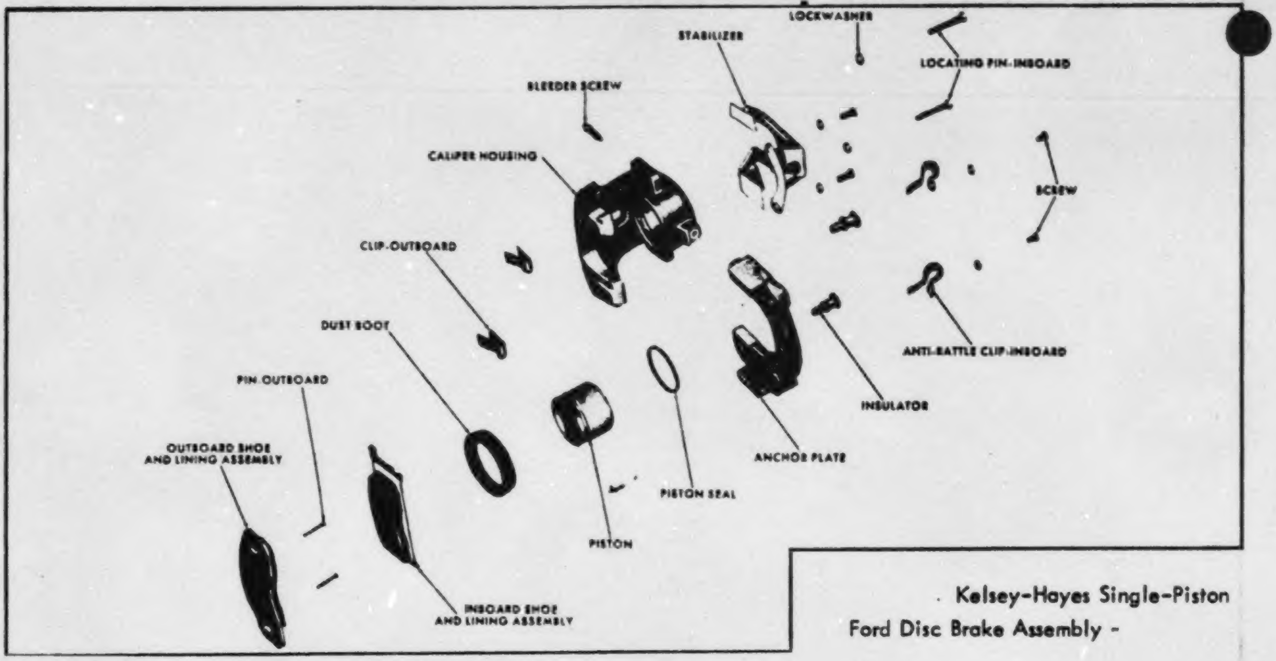
Assembly and Installation:

1. Adjust the ears of the outboard pad to provide a slight interference fit and install the pad in the caliper recess.
2. Install the inboard pad with the flanges inserted in the adapter "ways."
3. Position the caliper on the rotor with the caliper engaging the adapter "ways."
4. Install the anti-rattle springs and the caliper retaining clips and tighten the retaining screws to 15 ft. lb. (20 N-m) torque.
5. Fill the master cylinder with fresh brake fluid.
6. Obtain a high, hard pedal, refill the master cylinder, and road test the car.

Ford-Kelsey-Hayes--Front and Rear A. Front (Early)

Kelsey-Hayes caliper assembly is mounted on an anchor plate, which in turn, is mounted on the spindle with two bolts. The axis of the upper bolt is parallel to the vehicle centerline and that of the lower bolt is transverse the vehicle. This provides an extremely rigid foundation to take braking torque. The caliper is mounted on the anchor plate in such a way that it can "float" transversely to the centerline of the vehicle, yet is held firmly against movement in the direction of braking forces.

KELSEY-HAYES FLOATING CALIPER SINGLE-PISTON DISC BRAKE AS USED ON FORD MOTOR COMPANY CARS SERVICING PROCEDURES


LOCKWASHER
STABILIZER
LOCATING PIN-INBOARD
BLEEDER SCREW
CALIPER HOUSING
SCREW
CLIP-OUTBOARD
DUST BOOT
ANTI-RATTLE CLIP-INBOARD
PIN-OUTBOARD
INSULATOR
OUTBOARD SHOE AND LINING ASSEMBLY
ANCHOR PLATE
PISTON SEAL
PISTON
INBOARD SHOE AND LINING ASSEMBLY

Kelsey-Hayes Single-Piston Ford Disc Brake Assembly -

Note

Inspect the brake linings any time that the wheels are removed (tire rotation, etc.). Check both ends of the outboard lining by looking in at each end of the cliper (Fig. D-37). These are the points at which the highest rate of wear normally occurs. However, at the same time, check the lining thickness on the inboard shoe to make sure that it has not worn prematurely. Look down through the inspection hole in the top of the caliper to view the inboard shoe.

To make a thorough check of lining wear it is necessary to remove the caliper assembly. This should be done whenever the condition of the linings is doubtful.

IMPORTANT

A tapered wear pattern may occur on floating caliper disc brake linings because of the off-center anchor plate abutments. This causes the caliper to shift within the anchor plate and assume a slightly angular position. The resulting tapered linings have approximately the same service life as those in fixed caliper brakes.

To accurately check lining thickness, make three thickness measurements with a micrometer across the thinnest section of the shoe and lining. Replace all (4) shoe and lining assemblies on BOTH front wheels:

a) If the assembly has worn to a thickness of 0.230-inch (shoe and lining together) or 0.030-inch (lining material only) at any one of the three measuring locations.
b) If there is more than 0.125-inch taper from end to end (Fig. D-38).
c) If lining shows evidence of brake fluid comtamination.

If linings need replacement, remove caliper as described on next page.

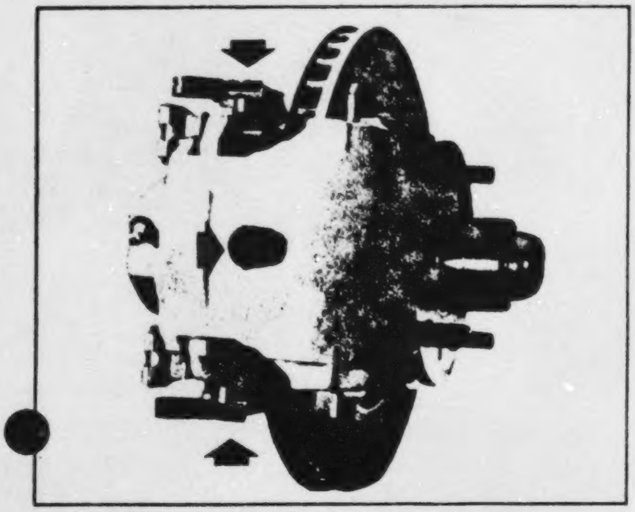


Fig.D37 - Inspect Shoes for Lining Wear

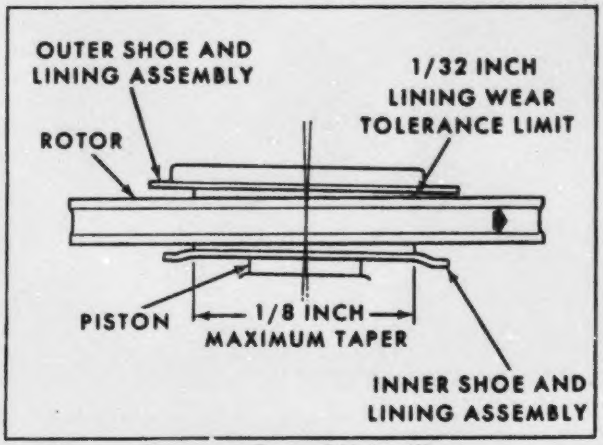

OUTER SHOE AND LINING ASSEMBLY
1/32 INCH LINING WEAR TOLERANCE LIMIT
ROTOR
PISTON
1/8 INCH MAXIMUM TAPER
INNER SHOE AND LINING ASSEMBLY

Fig.D38 - Tapered Lining Wear

BRAKE SHOE REPLACEMENT

Removing The Caliper Assembly

1. With vehicle raised evenly on a hoist or jackstands, remove the front wheels.

   Note
   If more than one brake requires service, work on only one brake at a time; however, shoe and lining assemblies must always be replaced in both brakes.

2. Locate brake line and wipe area around fitting at brake with a clean cloth to remove excess dirt and grease.
3. Remove the lockwires from the two anchor bolts which hold the caliper anchor plate to the steering knuckle, remove the two bolts and lift the caliper straight off of the rotor.
4. Use a wire hook or loop to hang cliper from vehicle suspension.

Removing Shoe and Lining Assemblies

1. Remove outboard shoe by using a screw driver (Fig. D-39) to remove clips and slide shoe and retaining pins out of caliper. Do not discard retaining pins or clips.
2. Remove inboard shoe by sliding it off the retaining clips (Fig. D-40).

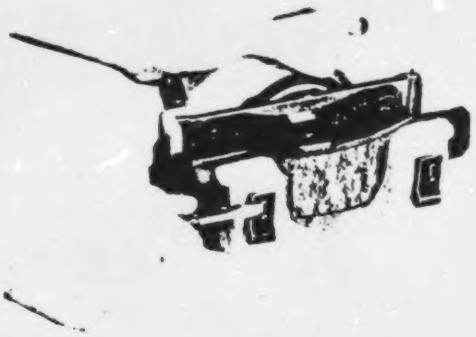


Fig. D39 - Removing Outboard Shoe and Lining Assembly

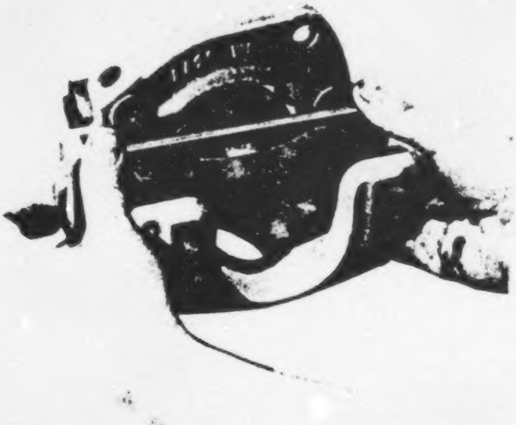


Fig. D40 - Removing Inboard Shoe and Lining Assem

INSTALLING SHOE AND LINING ASSEMBLIES

1. Slide inboard shoe backing plate tabs between retaining clips and anchor plate (Fig. D-41) until shoe lies flush against piston face.
2. Insert outboard shoe retaining pins into outboard shoe and position in caliper. (Fig. D-43)

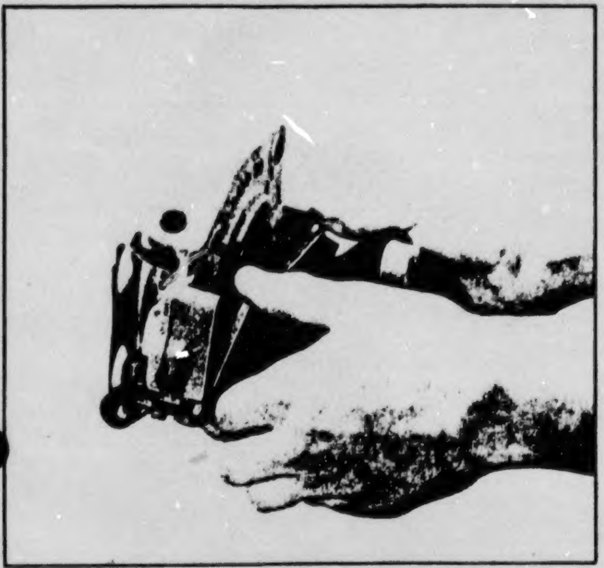


Fig. D41- Installing Inboard Shoe and Lining Assembly

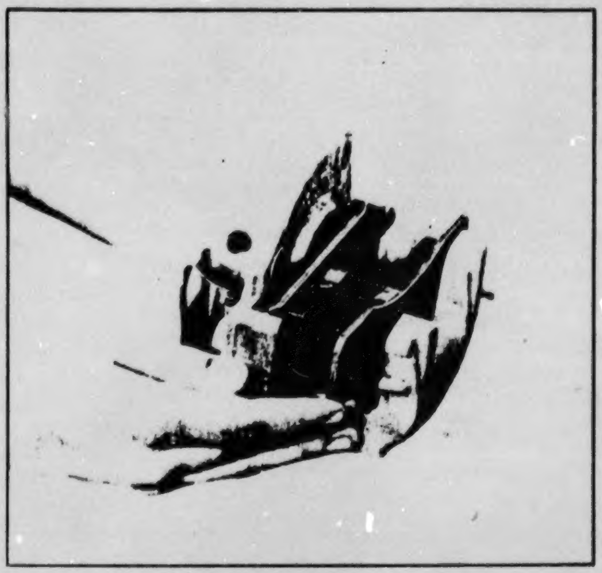


Fig. D43- Positioning Outboard Shoe and Lining Assembly in Caliper

3. Using a piece of 1/4" dowel x 1-1/4" long, hold the retaining pins in place (one at a time) and reinstall the retaining pin clips as shown (Fig. D-42). Caliper is now fully assembled and ready for reinstallation on vehicle.

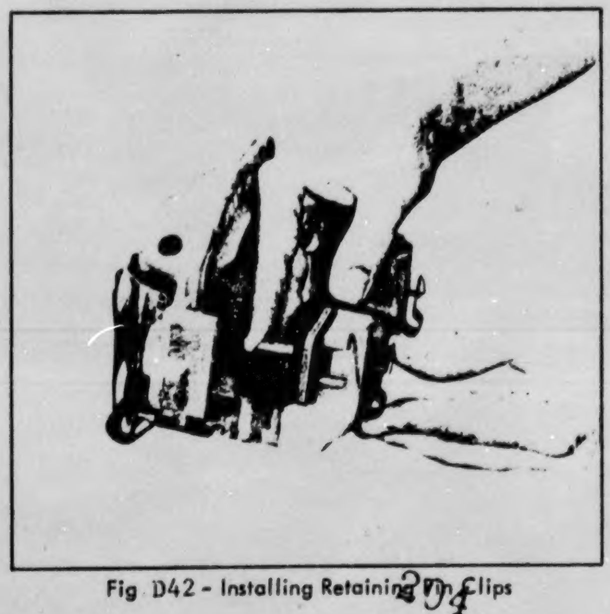


Fig D42 - Installing Retaining Pin Clips

INSTALLING THE CALIPER ASSEMBLY

1. Position caliper correctly over rotor and slide straight into position until anchor plate bolt holes align with their respective holes on the steering knuckle.
2. Install the lower bolt finger tight. Install the upper bolt and torque to specification. Torque the lower bolt to specification.

Note

The alignment of the anchor plate depends on proper sequence of bolt installation. Do NOT deviate from this procedure. Safety wire both bolts. Be sure specified wire wraps are made and sharp wire ends pointed away from brake hose.

Ford, Chevrolet Truck, IHC Sliding Caliper Disc Brake

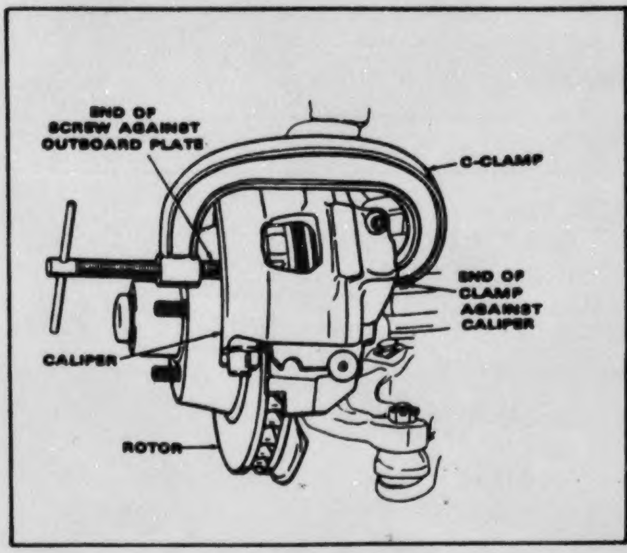

END OF SCREW AGAINST OUTBOARD PLATE
C-CLAMP
END OF CLAMP AGAINST CALIPER
CALIPER
ROTOR

Figure D44 Bottoming Caliper Piston

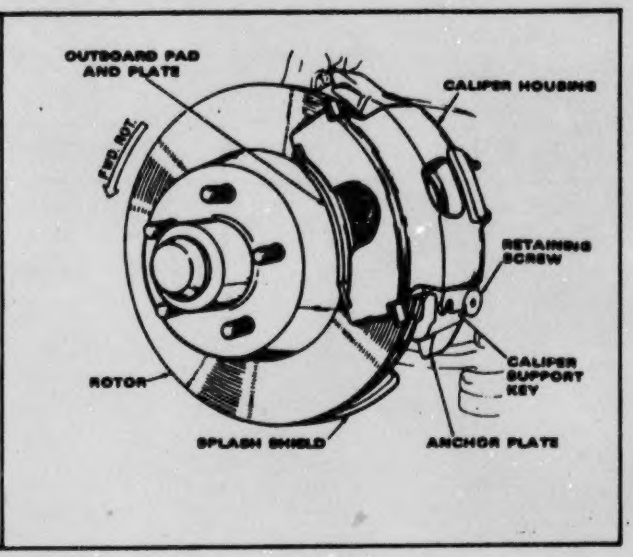

OUTBOARD PAD AND PLATE
CALIPER HOUSING
FWD ROT.
RETAINING SCREW
CALIPER SUPPORT KEY
ROTOR
SPLASH SHIELD
ANCHOR PLATE

Figure D45 Sliding Caliper Brake.

PAD AND PLATE REPLACEMENT

Note

Siphon or dip part of brake fluid out of larger master cylinder reservoir (reservoir connected to disc brakes). Discard fluid removed. Do not disconnect hydraulic hose from caliper.

Removal

1. Place a large (8-inch) C-Clamp on the caliper as illustrated in (Fig. D-44), and tighten clamp to bottom piston in cylinder bore. Then remove clamp.
2. Use a 1/4" Allen wrench to remove key retaining screw. (Fig. D-45)

Brake - Disc Brake Systems and Service

No. D-2 Disc Pad Replacement

3. Use a drift and light hammer to drive out caliper support key and caliper support spring. (Fig. D-46)
4. Remove caliper from anchor, and lay caliper on a tie rod or support strut. Do not let caliper hang with weight on brake hose.
5. Remove outboard pad and plate from caliper. (Fig. D-47) It may be necessary to tap plate to loosen plate flange from caliper.
6. Remove inboard pad and plate from anchor (Fig. D-48). and remove anti-rattle clip from lower notch of anchor.

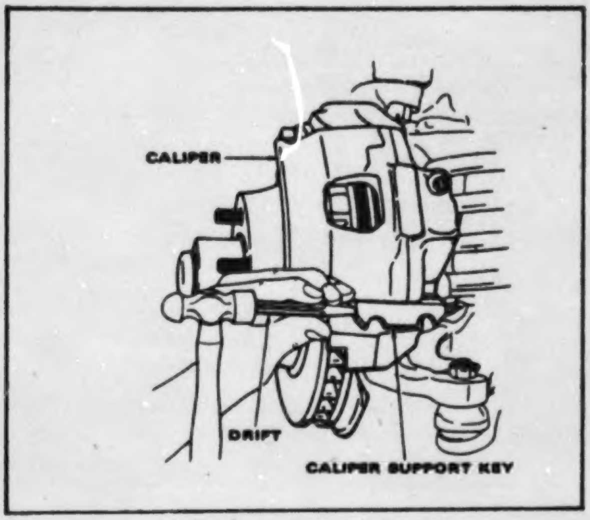

CALIPER
DRIFT
CALIPER SUPPORT KEY

Figure D46 Removing Caliper Support Key

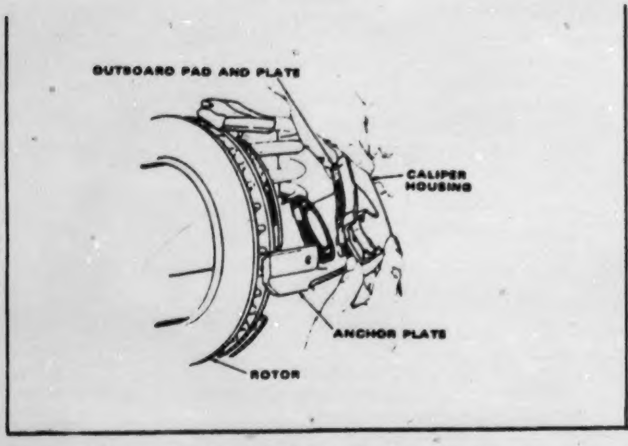

OUTBOARD PAD AND PLATE
CALIPER HOUSING
ANCHOR PLATE
ROTOR

Figure D47 Removing Outboard Pad and Plate

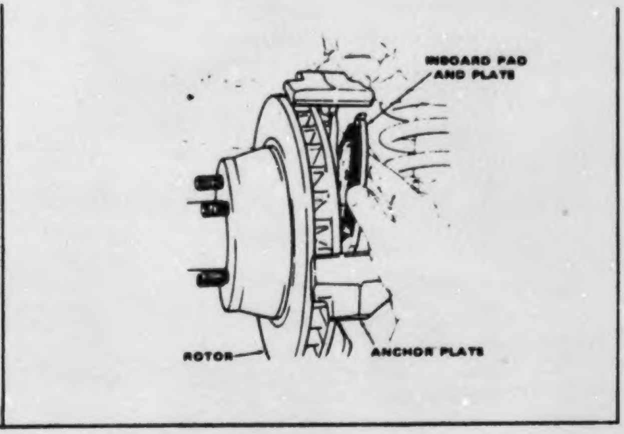

INBOARD PAD AND PLATE
ROTOR
ANCHOR PLATE

Figure D45 Removing Inboard Pad and Plate

6. Use a brake adjusting tool or screwdriver (Fig. D-50) to hold caliper in upper position in anchor. Then install caliper support spring and support key, (Fig. D-51).
7. Use a soft (brass or plastic) mallet to drive key and spring assembly into position. Then install key retaining screw.

Final Check

After new pads and plates are installed on both front brakes, check master cylinder reservoirs, and fill, if necessary.

Depress brake pedal several times to seat pads against rotor.

Re-check master cylinder reservoirs, and re-fill, it necessary.

Note:

Bleeding should not be necessary: however, if pedal feels soft or mushy, bleed the hydraulic system.

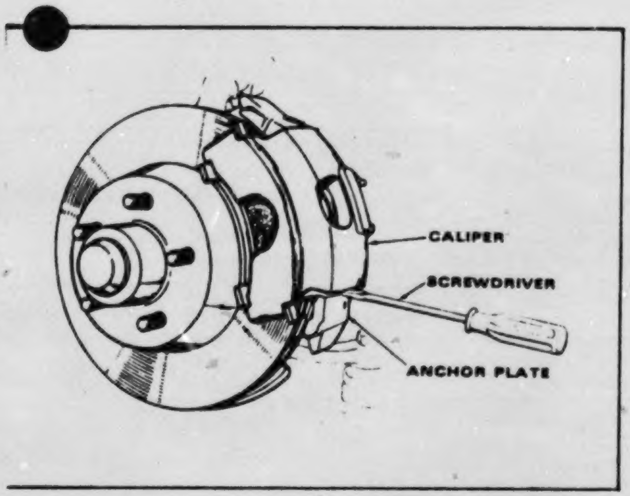


Figure D50 Holding Caliper in Anchor

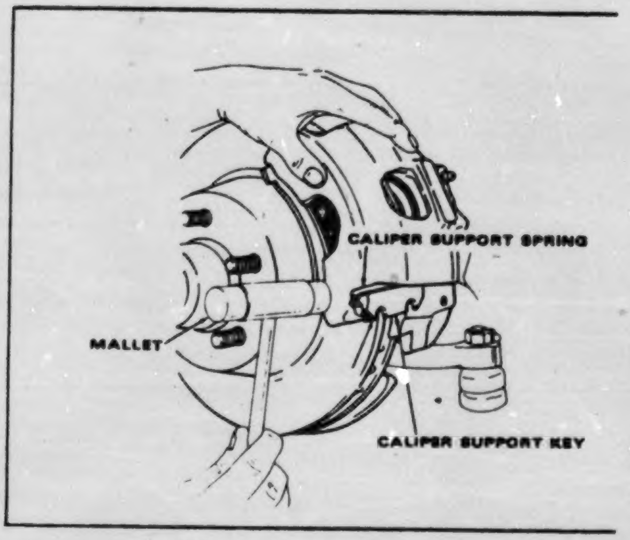


Figure D51 Installing Caliper Support Key

Cleaning and Inspection

Visually inspect caliper housing and area around dust boot for fluid leakage. If leakage is evident, overhaul the caliper.

Inspect anchor for defects, and replace anchor if defective.

Note

Normally the anchor mounting bolts should not be loosened unless the anchor is being replaced.

Use a wire bush to remove any rust or corrosion from machined surfaces of anchor and caliper. It is important to clean those areas of the caliper and anchor that are in contact during the sliding action of the caliper.

Installation

1. Position anti-rattle clip in lower shoe notch in anchor (Fig. D-49). Be sure that clip is positioned with loop type spring away from rotor.
2. Position inboard pad and plate in anchor.
3. Be sure that caliper piston is fully bottomed in bore. If necessary, use a large C-clamp to assist.

Note

The service replacement outboard pad and plate has longer tabs than the pad and plate installed on new cars.

4. Position outboard pad and plate on caliper, and use fingers to press plate tabs into place. If necessary, use a C-Clamp as shown in (Fig. D-49) to press plate into position. Be careful not to mar lining with C-Clamp.
5. Position caliper in anchor. Be careful when installing caliper to prevent tearing or cutting boot as it slips over inner shoe.

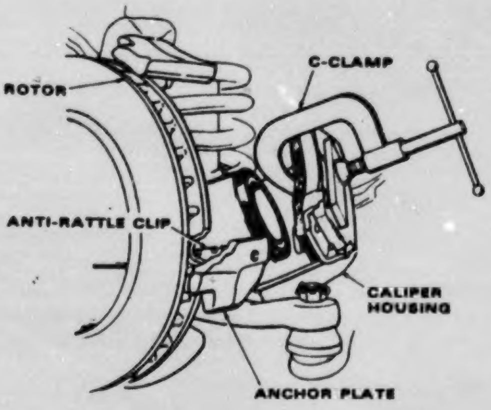


Figure D49nstalling Anti-Rattle Clip

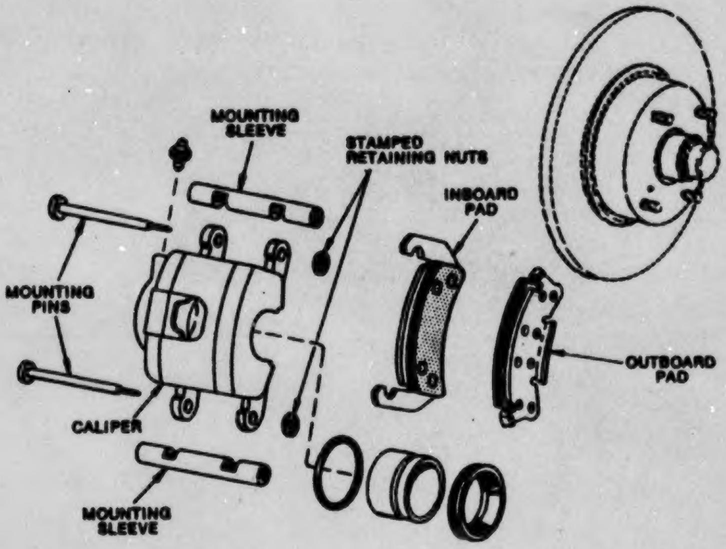


FIGURE D52 Chevrolet Vega-Monza Floating Caliper Disc Brake

CHEVROLET VEGA--MONZA GROUP

The sliding caliper disc brake used on the Chevrolet Vago-Monza group consists of a single piston design. Rotor, rotor shield, shoe and lining assembly, pistion assembly, caliper housing, mounting sleeves and other hardware are the important parts of this brake. A disassembled view of the Chevrolet Vega-Monza sliding caliper disc brake is shown in Fig. D-52.

Service Procedure:

Before starting any work, remove ½ of the brake fluid from the disc brake side of the reservoir, and discard. Replace the cover.

Disassembly and Removal:

1. Remove two stamped nuts from the mounting pins and remove the pins.
2. Lift the caliper off the rotor.
3. Support the caliper so it doesn't hang by the brake hose.
4. Use a large C-clamp to force the piston back into its bore, being careful not to cut or tear the dust boot.
5. Slide the pads past the mounting sleeve openings and remove the pads, sleeve, and bushing assemblies.

Assembly and Installation:

1. Install the sleeves with shouldered ends of the bushings to the outside of the car.
2. Install the pads in the caliper with the ears over the sleeve.
3. Position the caliper on the rotor.
4. Install the mounting pins.
5. Install the stamped nuts on the mounting pins using a small socket to press on as far as possible.
6. Fill the master cylinder with fresh fluid.
7. Obtain a high, hard pedal, refill the master cylinder, and road test the car.

Ford Pinto 1973-71-- Bendix

The Ford Pinto sliding caliper disc brake is a center abutment type made by Bendix. A disassembled view is shown in Fig. D-53.

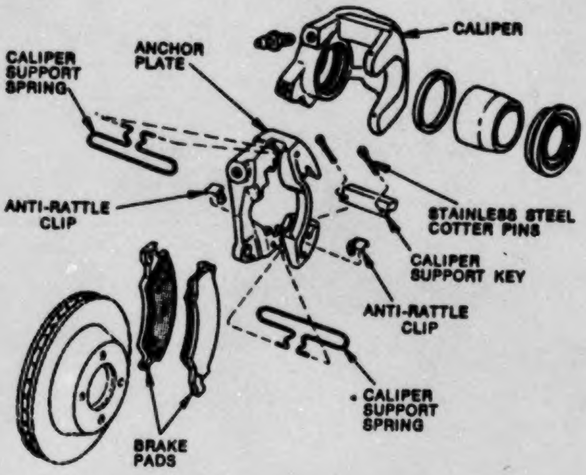

CALIPER
ANCHOR PLATE
CALIPER SUPPORT SPRING
ANTI-RATTLE CLIP
STAINLESS STEEL COTTER PINS
CALIPER SUPPORT KEY
ANTI-RATTLE CLIP
CALIPER SUPPORT SPRING
BRAKE PADS

FIGURE D53-Ford Floating Caliper Disc Brake (Pinto Design)

Disassembly and Removal:

1. Remove the stainless steel cotter-pins holding the caliper support key.
2. Use a hammer and drift to remove the caliper support key.
3. Lift the lower end of the caliper up and toward the rear, and remove from the rotor.
4. Support the caliper so it doesn't hang by the brake hose.
5. Use a large C-clamp to force the piston back into its bore, being careful not to scratch the piston or bore, and not to cut or tear the dust boot.
6. Tilt the upper edges of the pads away from the disc and remove the pads and anti-rattle clips from anchor plate.

Assembly and Installation:

1. Place the pads and anti-rattle clips in the anchor plate.
2. Position the caliper on the rotor, over the pads and in the anchor plate with the upper support spring under the caliper projecting ledge.
3. Pry the caliper upward and inward, at the lower edge, and insert the caliper support key between the caliper and the anchor plate. Make sure the support springs are still in position.
4. Install new stainless steel cotter pins in the caliper support key on each side of the anchor plate.
5. Fill the master cylinder with fresh fluid.
6. Obtain a high, hard pedal, refill the master cylinder and road test the car.

General Motors-Rear Disc Brake

A four-wheel disc brake system with Hydro-boost is used exclusively on the Eldorado. The 11 inch (279 mm) diameter single piston disc brakes with an integral parking brake with automatic adjusting provisions and new brake linings are used in the rear. The front and rear brake caliper and linings are not interchangeable.

Fig. D-54 shows a cross-section of a rear brake caliper. The cone and piston move out as one part upon hydraulic apply. The nut remains stationary on the high lead screw and a gap develops between the cone and nut. The caliper adjusts only when there is no pressure over the cone, thus, allowing it to rotate on the clutch interface (it will not automatically adjust on hydraulic apply). The clutch interface prevents the cone from turning when the parking brake is applied.

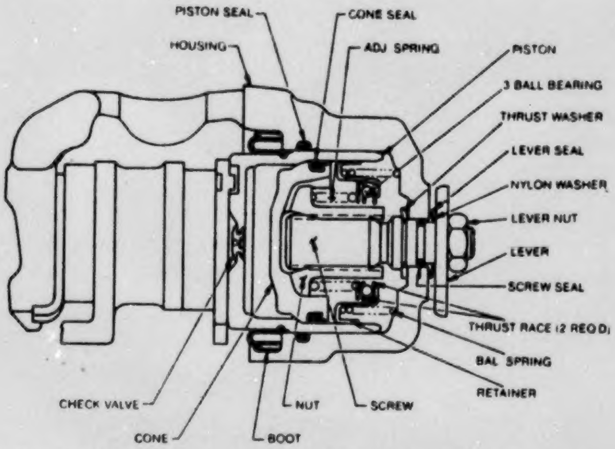


FIGURE D54 **—Cross-Section of a GM Rear Brake Caliper**

Rear Brake Caliper:

a) Removal-Remove wheel disc and wheel tire assembly. Remove cable from parking brake lever. Remove return spring, lock nut, lever, lever seal, and anti-friction washer. Use a standard C-clamp as described earlier , and turn it until postion bottoms in the caliper. Then install new anti-friction washer, lever seal, lever, lever return spring, and remove C-clamp. Remove brake line from caliper and plug openings to retain fluid and prevent entrance of dirt. Remove caliper mounting bolts, and remove caliper together with brake shoes; then remove shoes.

b) Inspection--Clean dirt and corrosion from piston face. Examine piston and check valve areas for fluid leaks. Check dust boot for cracks, cuts, or other damages. If leaks are present, replace dust boot. CAUTION: Do not use air for cleaning caliper because of the possibility of unseating dust boot.
Replace piston seal and boot seal, if leaking. Also check for leaks at the threaded end of actuator screw. If bore is nicked or scratched, replace caliper.

c) Lining Replacement--Remove and discard two caliper mounting sleeves and four bushings. Using silicone lube, install new bushings and sleeves. Remove and discard piston check valve, and install a new one. Position new inboard shoe assembly on piston. If piston requires rotation, use the special tool. D-shaped tab must fit in the indentation provided in the piston. Install new outborad shoe assembly. Wipe all dirt from caliper mounting bolts.

d) Installation--After making sure that all sleeves, bushings and pins are well-lubricated with silicone lube, slide caliper over rotor and install mounting bolts. Unplug fittings and install brake line tube nut into caliper. Pump brake pedal to seat lining against rotor. Clinch upper ear of outboard shoe by using pliers (see Fig. D-26). Connect parking brake cables, and adjust parking brake. Bleed rear brake system. Apply brake several times to insure adjustment, and install wheel disc.

IMPORT CAR DISC BRAKES

Typically, a majority of the imported cars use fixed rather than the floating calipers. Some are equipped with four wheel disc brakes. ATE (TEVES), and Girling are the two types of disc brakes most commonly used on the imported cars. Other types are used, but their design and operation are virturally the same

Opel, Volkswagen (ATE-TEVES) Brakes

Two-piston disc brake of the ATE-TEVES type is shown in Fig. D-55. The caliper is a two-piece unit, held together by four bolts. The two brake pads are held in the caliper on two retaining pins and by a cross-leaf spreader spring which presses the pads against the pistons. The pads have linings on both sides of the shoe backing. The thinner side is toward the piston and acts as a heat insulator. Located behind the pad insulator is an anti-rattle plate (some models) and a piston positioning plate which keeps the piston from rotating. Piston dust boots are held on the caliper halves by the clamp rings.

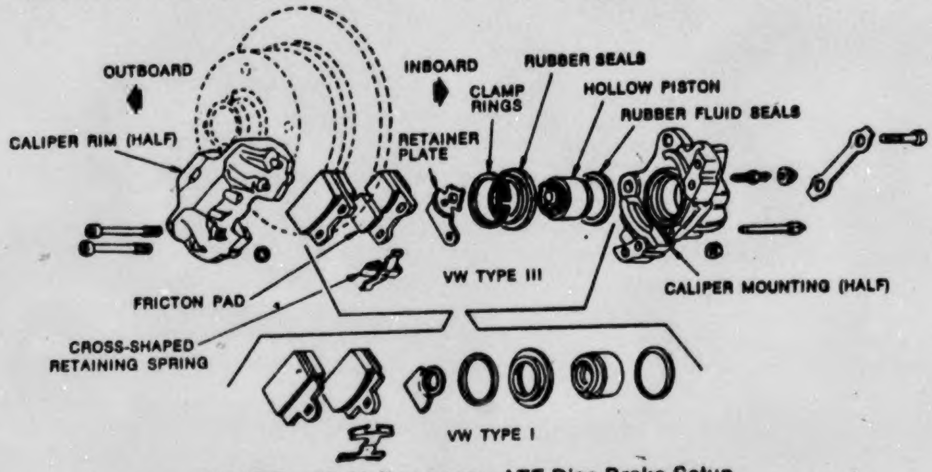


FIGURE D55—Volkswagen—ATE Disc Brake Setup

The operating principle of ATE disc brakes is similar to the Kelsey-Hayes design, in that the square piston seal pulls the piston back slightly into the caliper bore when the brake pedal is released. The seal and the piston spring act together to provide a running clearance between the brake pads and the disc brake rotor.

The disc brake pistons of some Volkswagen cars (VW type I and III) use a spring-loaded automatic compensating mechanism to prevent the piston "knock-back", and to maintain the proper clearance between the disc brake pads and the brake rotor. This part is non-serviceable and must be replaced, if found defective.

Service Procedure:

Before starting any work, remove ½ of the brake fluid from the disc brake side of the reservoir, and discard. Replace the cover. Do not, under any circumstances, loosen or remove the caliper bridge bolts and separate the caliper into halves.

Disassembly and Removal:

1. Pads--The pad retaining pins are held by lock rings in the inboard caliper half. From the outboard side, knock out the pins with a hammer and a punch. The spreader spring can then be removed. Use pliers or hooks to lift out the pads, being careful not to damage the rotor.
2. Caliper--Disconnect the brake hose and remove the two mounting bolts which attach the caliper to the steering knuckle. Slide the caliper off of the rotor.
3. If the pistons must be removed, then first remove the caliper and drain. Pry the positioning plate from the caliper, then remove the dust boot clamp ring with a small screw driver. Protect the pistons with a shop towel and apply low air pressure at the inlet port to force out a piston. Only one piston can be serviced at a time. Remove the second piston in a similar manner.

Assembly and Installation:

1. Pistons--A special gauge with a 20 degree angle, or the piston positioner plate, must be used to locate the position of the piston face. Measurement is always on the side opposite from the bleeder screw. After positioning and forcing in the piston, install the dust boot and the positioner plate.
2. Caliper--Position the caliper over the rotor and install the mounting bolts, tightening to the specified torque.
3. Pads--Locate the pads and anti-rattle (if used) in approximate alignment on each side of the rotor. Hammer the lower retaining pin in from the inboard side aligning plates and shoes on the pin as it goes. Then hook one side of the cross-shape spreader spring under the pin. Depress the free end of the spring so that the upper pin can push past it and hammer the upper pin in place. Before operating the vehicle, operate the brake pedal several times to restore the linings to their operating position.

Toyota (Girling) Brakes

Girling disc brakes are used on a wide variety of imported cars. These are similar to the ATE disc brakes except that the piston seal does not pull the piston and the brake pads away from the rotor. With the pistons in the relaxed position, the pad just touches the rotor. A disassembled view of the Toyota fixed caliper two-piston disc brake which uses a Girling design, is shown in Fig. D-56.

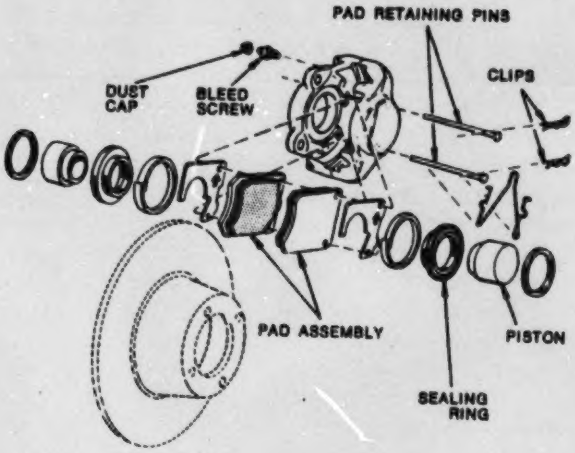


FIGURE D56–Toyota—Girling Disc Brake Setup

Depending on the application, the retaining pins and clips many be replaced by large cotter pins. Girling disc brakes are simple to service, and the servicing procedures are basically similar to the one described for ATE (TEVES) brakes.

The Girling rotor service, however, is slightly different than the regular procedure. The Girling has supplied rotors with three different thicknesses: 0.375" (9.52 mm), 0.500" (12.70 mm), and 0.5625" (14.29mm). If any Girling disc has to be refinshed its minimum thickness is the original thickness less 0.050" (1.27 mm). For the original thickness, the Vehicle manufacturer's specifications should be referenced. The disc runout should not exceed 0.004" (0.10 mm) for any of these disc rotors. As a general rule, replace the pads if the lining thickness (on the Girling brakes) falls below o.125" (3.18 mm).

On cars using the Girling design for parking brakes, the clearance for parking brakes, the clearance for parking brake linings should not exceed 0.003" (0.08 mm). To replace, remove the adjusting nut on the cable or pull rod. Swing the two clamping levers outward, clean all parts, insert new pads, and reassemble.

The disc brake rotor should be inspected and, if necessary, serviced, using the same procedures as for the domestic cars; taking care to inspect the rotor for the excessive wear. A micrometer should be used for checking the rotor thickness and parallelism, and a dial indicator for measuring the runout.

Brakes - Disc Brake System and Service

No. D-2

Worksheet # 5

Name________________________________Date_______________Grade_________

Replace Front Disc Brake Shoes: Delco-Moraine Floating Type

Vehicle Identification Year ______ Make ______ Model ______

Flat Rate Time ________hrs.

1. Follow the steps in the following general "Procedure Outline".
2. Because there could be variations in the design and mounting of this type of caliper, you should also use the manufacturer's service manual to obtain specifications and specific procedures for the car on which you are working.

PROCEDURE OUTLINE

1. Partially drain the reservoir.
2. Raise and support the car, and remove the wheel.
3. Push the caliper piston back in its bore.
4. Remove and support the caliper.
5. Remove the shoes.
6. Remove the sleeves and bushings.
7. Clean and inspect all parts.
8. Install new sleeves and bushings.
9. Install the new brake shoes.
10. Install the caliper.
11. Check the pedal feel and fluid level.
12. Repeat operations 1 to 11 at the opposite wheel.
13. Install the wheels, and lower the car to the floor.
14. Road test the car for proper brake operation.

Time on Job ______hrs. Instructor's Initials ________

Brakes - Disc Brake System and Service

No. D-2

Worksheet # 6

Name______________________________Date______________Grade________

Replace Front Disc Shoes: Kelsey-Hayes Floating Caliper Type (Chrysler - AMC)

Vehicle Identification Year _____ Make _____ Model _____

Flat Rate Time _____ hrs.

1. Follow the steps in the following general "Procedure Outline".
2. Because there could be variations in the design and mounting of this type of caliper, you should also use the manufacturer's service manual to obtain specifications and specific procedures for the car on which you are working.

PROCEDURE OUTLINE

1. Partially drain the reservoir.
2. Raise and support the car, and remove the wheel.
3. Bottom the caliper piston in its bore.
4. Remove and support the caliper.
5. Remove the shoes.
6. Remove the rubber bushings.
7. Clean and inspect all parts.
8. Install the new rubber bushings.
9. Install the brake shoes.
10. Install the caliper.
11. Check the pedal feel and fluid level.
12. Repeat the operations at the opposite wheel.
13. Install the wheels, and lower the car to the floor.
14. Road test the car for proper brake operation.

Time on Job _______ hrs.

Instructor's Initials _______

Brakes - Disc Brake System and Service

No. D-2

Worksheet # 7

Name______________________________Date____________Grade_______

Replace Front Disc Brake Shoes: Kelsey-Hayes Sliding Caliper
(Late) Chrysler, Full Size 73-77

Vehicle Identification Year ______ Make ______ Model ______

Flat Rate Time ______ hrs.

1. Read information sheet 2, p. 12.

2. Because there could be variations in the design and mounting of this type of caliper you should also use the manufacturer's service manual to obtain specifications and specific procedures for the car on which you are working.

PROCEDURE OUTLINE

1. Remove the attaching screws and lift off the splash shield and/or the anti-rattle hardware, or the pad retaining clips.

2. Pry the caliper pistons back into their bores. Pry both pistons at once so as not to force one out of the caliper bore.

3. Provide some clearance by grasping one edge of the shoe and the caliper housing with water pump pliers and work the shoe back and forth.

4. Using two pairs of pliers, grasp the tabs at each end of shoe and pull the pad straight out of the caliper.

5. Slide a new pad into position, making sure the pad ears rest solidly on the bridges of the caliper.

6. After replacing the first pad, repeat this procedure for the other end.

7. Reinstall the brake pad retaining hardware.

8. Fill the master cylinder with fresh brake fluid.

9. Obtain a high, hard pedal, refill the master cylinder, and road test the car.

Time on Job ______hrs.

Instructor's Initials________

Brakes - Disc Brake System and Service

No. D-2

Worksheet # 8

Name____________________________________ Date________________ Grade________

Replace Front Disc Brake Shoes: Ford Type

Vehicle Identification Year ______ Make ______ Model ______

Flat Rate Time ______hrs.

1. Follow the steps in the following general "Procedure Outline".
2. Because there could be variations in the design and mounting of the type of caliper, you should also use the manufacturer's service manual to obtain specifications and specific procedures for the car on which you are working.

PROCEDURE OUTLINE

1. Partially drain the reservoir.
2. Raise and support the car, and remove the wheel.
3. Bottom the caliper piston in its bore.
4. Remove and support the caliper.
5. Remove the shoes.
6. Clean and inspect all parts.
7. Install the brake shoes.
8. Install the caliper.
9. Check the pedal feel and the fluid level.
10. Repeat operations 1 to 9 at opposite wheel.
11. Install the wheels, and lower the car to floor.
12. Road test the car for proper brake operation.

Time on Job ________hrs. Instructor's Initials ________

Brakes - Disc Brake System and Service

No. D-2

Worksheet # 9

Name________________________________Date________________Grade________

Replace Front Disc Brake Shoes: Kelsey-Haye Sliding Caliper Type
Ford, Chevrolet Truck, Inc.

Vehicle Identification Year ______ Make______ Model ______

Flat Rate Time _______hrs.

1. Follow the steps in the following general "Procedure Outline".
2. Because there could be variations in the design and mounting of this type of caliper, you should also use the manufacturer's service manual to obtain specifications and specific procedures for the car on which you are working.

PROCEDURE OUTLINE

1. Partially drain the reservoir.
2. Raise and support the car and remove the wheel.
3. Remove and support the caliper.
4. Remove the shoes.
5. Clean and inspect all parts.
6. Bottom the caliper piston in its bore.
7. Install the brake shoes.
8. Install the calipers.
9. Check the pedal feel and the fluid level.
10. Repeat operations 1 to 9 at opposite wheel.
11. Install the wheels, and lower the car to the floor.
12. Road test the car for proper brake operation.

Time on Job _______hrs.

Instructor's Initials _______

Brakes - Disc Brake System and Service

No. D-2

Worksheet # 9

Name________________________________Date______________Grade________

Replace Front Disc Brake Shoes: Kelsey-Haye Sliding Caliper Type
Ford, Chevrolet Truck, Inc.

Vehicle Identification Year ______ Make______ Model ______

Flat Rate Time _______hrs.

1. Follow the steps in the following general "Procedure Outline".
2. Because there could be variations in the design and mounting of this type of caliper, you should also use the manufacturer's service manual to obtain specifications and specific procedures for the car on which you are working.

PROCEDURE OUTLINE

1. Partially drain the reservoir.
2. Raise and support the car and remove the wheel.
3. Remove and support the caliper.
4. Remove the shoes.
5. Clean and inspect all parts.
6. Bottom the caliper piston in its bore.
7. Install the brake shoes.
8. Install the calipers.
9. Check the pedal feel and the fluid level.
10. Repeat operations 1 to 9 at opposite wheel.
11. Install the wheels, and lower the car to the floor.
12. Road test the car for proper brake operation.

Time on Job ______hrs.

Instructor's Initials _______

Brakes - Disc Brake System and Service

No. D-2 Floating Caliper

Worksheet # 10

Name______________________________Date______________Grade_________

Replacement of Disc Brake Shoes (Chevrolet Vega - Monza Group)

Vehicle Identification Year ______ Make ______ Model ______

Flat Rate Time ________hrs.

1. Read Information Sheet 2, p. 22.
2. Follow the steps in the following general "Procedure Outline".

Disassembly and Removal:

1. Remove two stamped nuts from the mounting pins and remove the pins.
2. Lift the caliper off the rotor.
3. Support the caliper so it doesn't hang by the brake hose.
4. Use a large C-clamp to force the piston back into its bore, being careful not to cut or tear the dust boot.
5. Slide the pads past the mounting sleeve openings and remove the pads, sleeves, and bushing assemblies.

Assembly and Installation:

1. Install the sleeves with shouldered ends of the bushings to the outside of the car.
2. Install the pads in the caliper with the ears over the sleeves.
3. Position the caliper on the rotor.
4. Install the mounting pins.
5. Install the stamped nuts on the mounting pins using a small socket to press on as far as possible.
6. Fill the master cylinder with fresh fluid.
7. Obtain a high, hard pedal, refill the master cylinder, and road test the car.

Time on Job ________hrs.

Instructor's Initials ________

Brakes - Disc Brake System and Service

No. D-2 Floating Caliper

Worksheet # 11

Name________________________________ Date_______________ Grade________

Replace Disc Brake Shoes (Pinto)

Vehicle Identification Year _____ Make _____ Model _____

Flat Rate Time _______hrs.

1. Read Information Sheet 2, p. 23.
2. Follow the steps in the following general "Procedure Outline".

After removing half the brake fluid, the following service procedure should be adopted.

Disassembly and Removal:

1. Remove the stainless steel cotter-pins holding the caliper support key.
2. Use a hammer and drift to remove the caliper support key.
3. Lift the lower end of the caliper up and toward the rear, and remove the rotor.
4. Support the caliper so it doesn't hang by the brake hose.
5. Use a large C-clamp to force the piston back into its bore, being careful not to scratch the piston or bore, and not to cut or tear the dust boot.
6. Tilt the upper edges of the pads away from the disc and remove the pads and anti-rattle clips from anchor plate.

Assembly and Installation:

1. Place the pads and anti-rattle clips in the anchor plate.
2. Position the caliper on the rotor, over the pads and in the anchor plate with the upper support spring under the caliper projecting ledge.
3. Pry the caliper upward and inward, at the lower edge, and insert the caliper and the anchor plate. Make sure the support springs are still in position.
4. Install new stainless steel cotter pins in the caliper support key on each side of the anchor plate.
5. Fill the master cylinder with fresh fluid.
6. Obtain a high, hard pedal, refill the master cylinder, and road test the car.

Tone on Job ______hrs. Instructor's Initials________

Auto Mechanics

No. D-3

OBJECTIVE: After completing this unit, the student will be able to rebuild the cylinder in a fixed caliper disc brake system.

EXPLANATION: The caliper must be rebuilt if they have any leak in them. They should also be rebuilt each time that the pads are replaced.

MATERIALS NEEDED: Safety glasses, brake fluid, caliper boots and seals, shop towels, mechanics wire

TOOLS NEEDED: Ratchet, sockets, torque wrench, compressed air, cylinder hose, piston puller

References	Do
#1. p. 29-28	#1. Read reference
#2. --	#2. Study information sheets.
#3. pp. 519 -522	
#4. pp. 448-450	
#5. p. 526	
#6. pp. 581-582	
#7.	
#8.	

No. D-3 Caliper Rebuild

Information Sheet # 1

REBUILD FIXED CALIPERS

Check the caliper for evidence of fluid leakage, (Fig. D-57). If leakage is indicated, the caliper should be overhauled. The rubber dust boots should be properly mounted and free from cracks, cuts, or other damage. Just as in drum brake wheel cylinders, the caliper piston seal will be repositioned on an unused surface when new shoes are installed. This may produce a leak after the brake job is completed, even if there was no leakage before. It is, therefore, considered good practice to overhaul the caliper when the shoes are replaced.

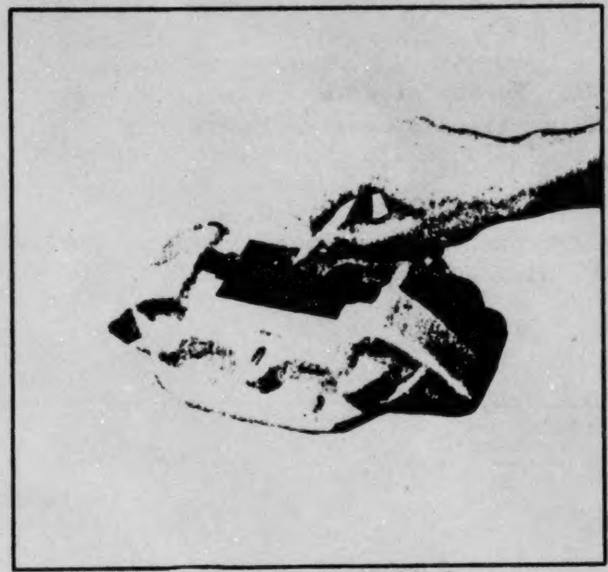


Fig. D-57 Inspect for Fluid Leakage and Damaged Dust Boot

DISASSEMBLING THE CALIPER

1. Remove the shoe and lining assemblies. If they are to be reused, identify each shoe so that it can be installed in its original position upon reassembly.
2. Open the bleed screw and drain the brake fluid from the caliper assembly.

3. Remove the four bolts which hold the two housing assemblies together (Fig. D-58).

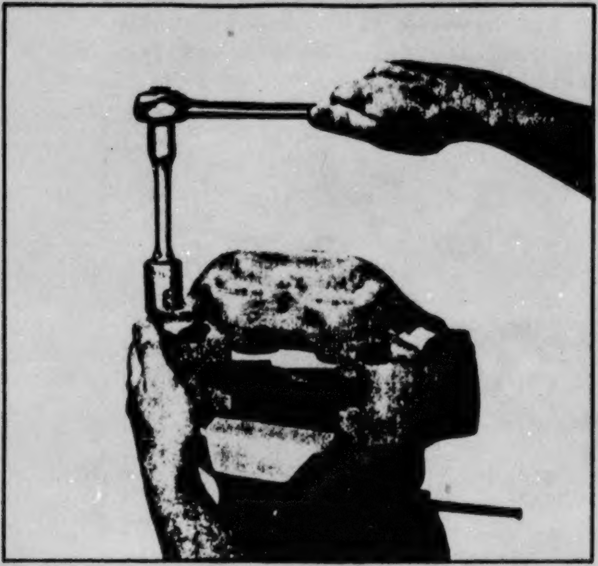


Fig. D-58 Remove Four Caliper Bolts

4. Separate the two housing assemblies and remove and discard the two "O" ring crossover seals (Fig. D-59).

5. Use a small screwdriver to remove the end of each dust boot retainer spring from its groove (Fig. D-60).

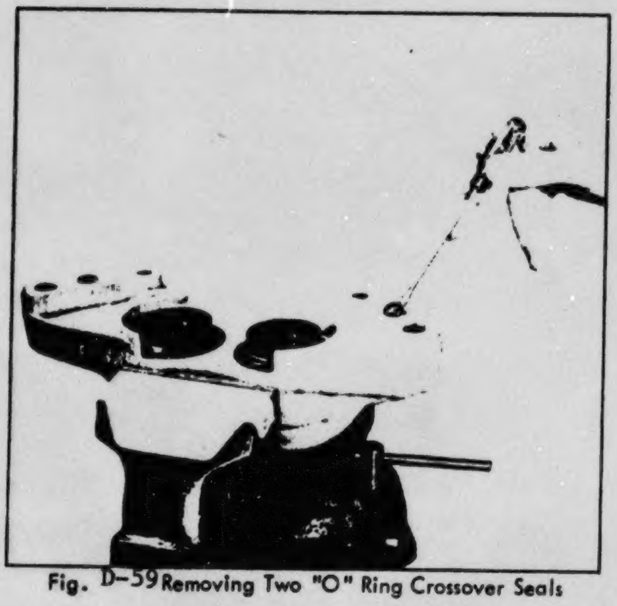


Fig. D-59 Removing Two "O" Ring Crossover Seals

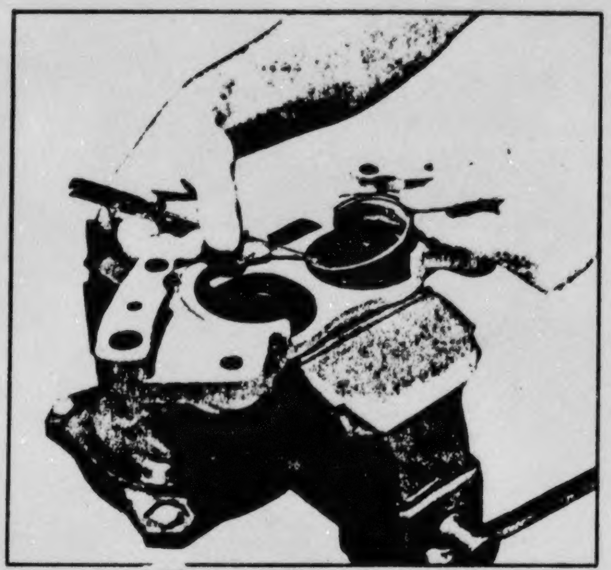


Fig. D-60 Removing Boot Retainer Spring

6. Press each piston into its bore and work the dust boot out of the groove in the housing (Fig. D-61).

7. Remove the piston assemblies from their bores (Fig. D-62).

8. Remove the piston springs from the bottom of the bores (Fig. D-62).

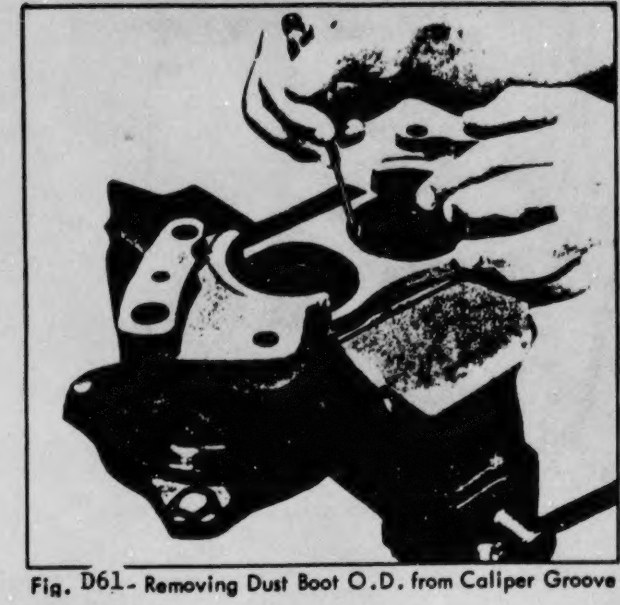


Fig. D61 - Removing Dust Boot O.D. from Caliper Groove

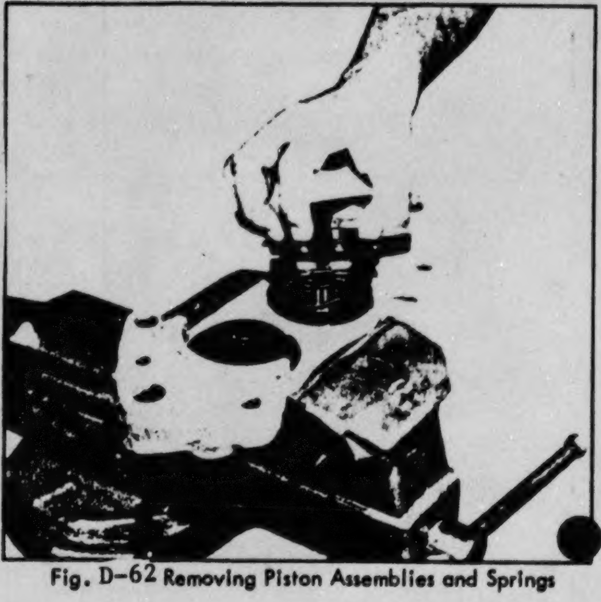


Fig. D-62 Removing Piston Assemblies and Springs

9. Remove the dust boots and piston seals from their grooves in the pistons (Fig. D-63).

10. Clean all parts with denatured alcohol using a lint-free cloth. Use an air hose to blow out all fluid passages and cylinder bores.

11. Inspect each cylinder bore for scoring, pitting or corrosion.

12. Polish any discolored or stained area with crocus cloth. Rotate the crocus cloth in the cylinder bore, using finger pressure. Do not slide the cloth in or out under pressure. Do not use any other form of abrasive or abrasive cloth. If the bore will not clean up in this manner, the housing

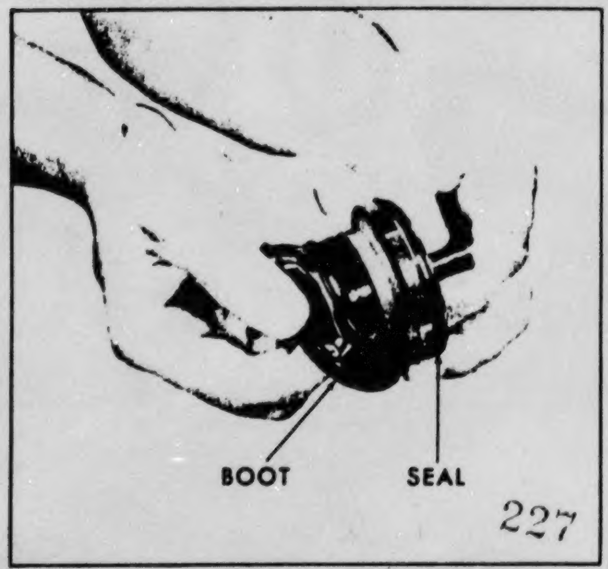


Fig. D63 - Removing Boot and Seal from Piston

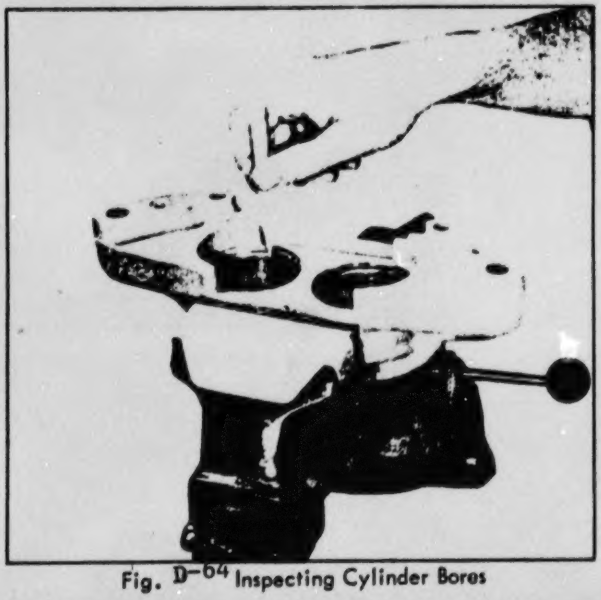


Fig. D-64 Inspecting Cylinder Bores

should be replaced. Black stains on the piston bore walls are caused by the piston seals and will do no harm.

13. If pistons are worn, pitted, or corroded severely, the caliper asembly must be discarded and replaced.

ASSEMBLING THE CALIPER

IMPORTANT

Replace all rubber parts with new parts whenever a caliper is disassembled for service.

1. Clamp the outboard caliper half in a vise and coat the cylinder bores with clean brake fluid (Fig. D-65).
2. Install the piston return springs in their seats in the piston bores (Fig. D-66).
3. Coat the piston and piston seal with clean disc brake fluid and assemble the piston seal into its groove in the largest O.D. of the piston.

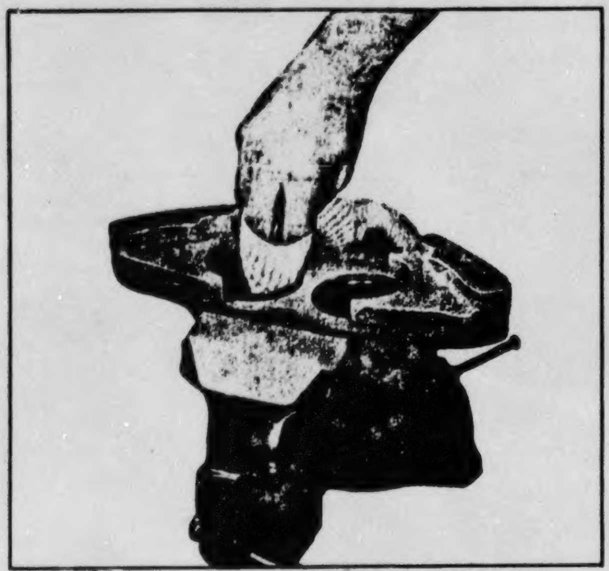


Fig.D65 - Coat Cylinder Bores with Clean Brake Fluid

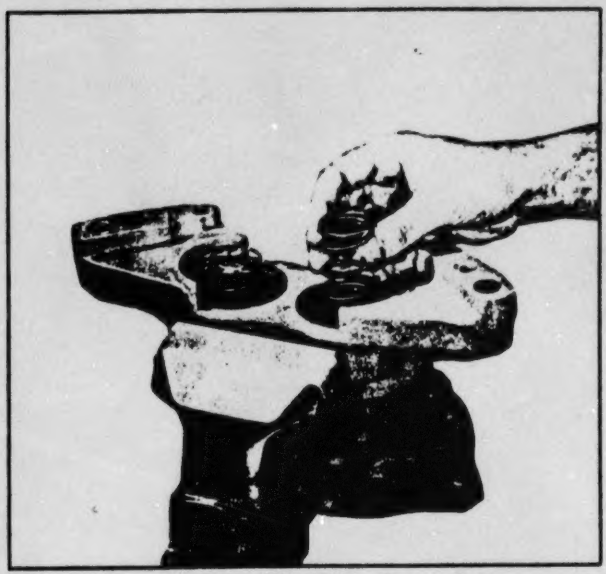


Fig. D66- Installing Piston Return Spring

4. Install the dust boot on the piston, so that the lip of the seat on the O.D. of the boot is toward the piston insulator pad (Fig. D-67).

5. Position the piston assembly on the return spring and press into its cylinder bore unitl it bottoms (Fig. D-68).

6. Work the lip of the dust boot into the groove around the O.D. of the bore. Use extreme care in installing boot and retainer. A damaged boot will allow contaminants to enter and corrode the piston and piston bore.

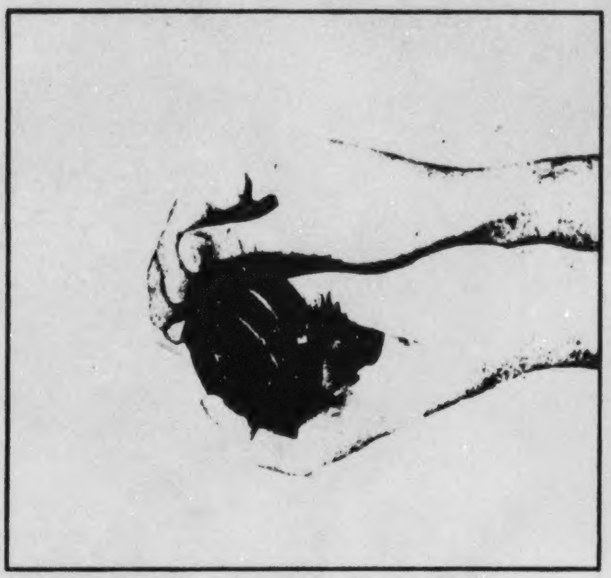


Fig.D67 - Assembling Boot on Piston

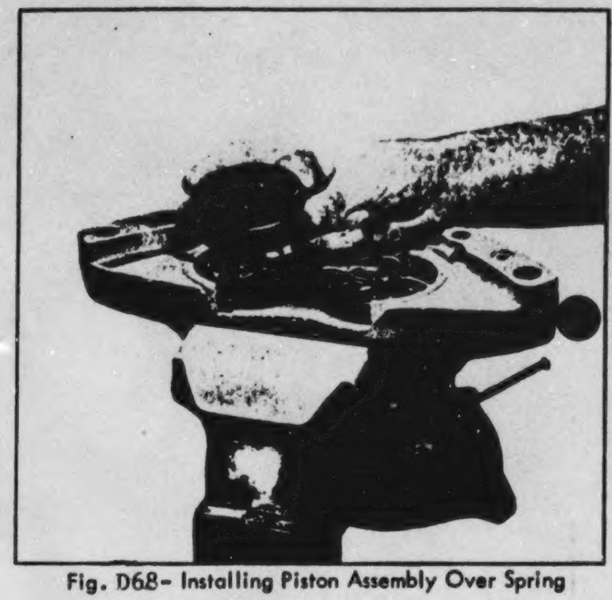


Fig. D68- Installing Piston Assembly Over Spring

7. Install the boot retainer spring by inserting one end in position over boot in groove and continue to work the spring into the groove until it is fully seated (Fig. D-69).

8. Repeat steps (3) thru (7) to install the remaining pistons. Press the pistons to bottom in their bores to test for smooth operation.

9. After all four pistons are correctly installed, place new cross-over "O" ring seals into position around the crossover holes. (Fig. D-70).

10. Place the inboard housing assembly on the outboard housing and install the four bolts. Tighten to specification (Fig. D-71).

11. Install shoe and lining assemblies in the caliper cavity. Place a block of smooth wood or plastic between the shoe and lining assemblies to hold them apart. The block must be wider than the rotor but thin enough to slip out the top of the caliper as it is positioned over the rotor.

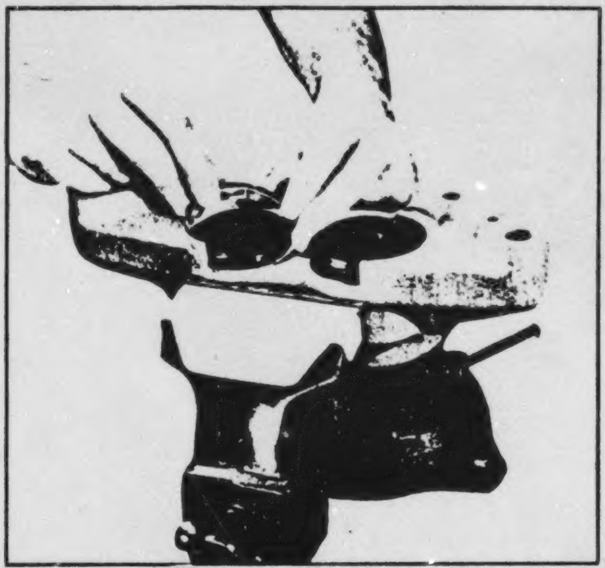


Fig. D69- Installing Boot Retainer Spring

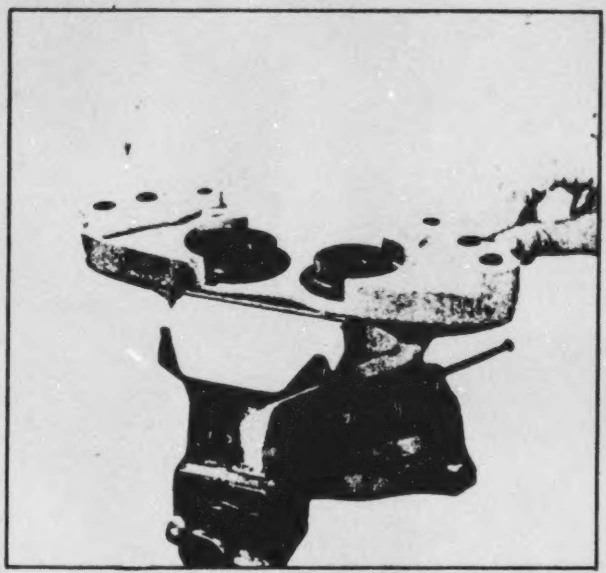


Fig. D70 Installing "O" Ring Crossover Seals

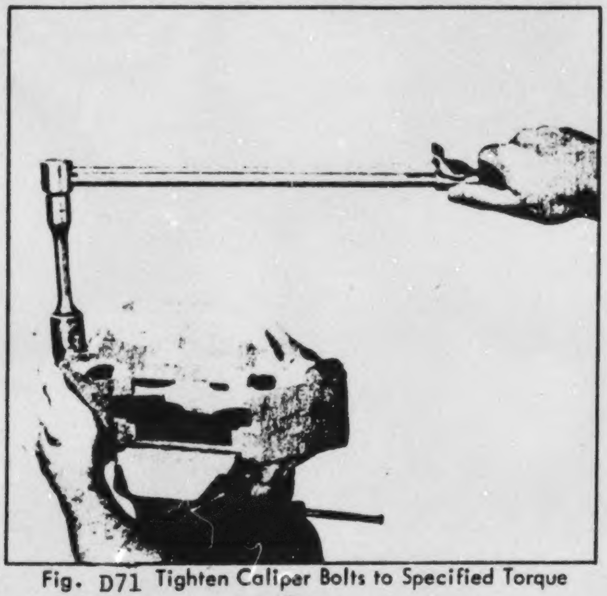


Fig. D71 Tighten Caliper Bolts to Specified Torque

Brakes - Disc Brake System and Service

No. D-3

Worksheet # 1

Name______________________________________Date_________________Grade_________

Overhaul A Ford or Kelsey-Hayes Caliper

Vehicle Identification Year ______ Make ______ Model ______

Flat Rate Time _______hrs.

1. Follow the steps in the following general "Procedure Outline".
2. Check manufacturer's service manual for specific procedures.

PROCEDURE OUTLINE

1. Remove the caliper from the car.
2. Disassemble the caliper.
3. Clean the parts.
4. Inspect the parts.
5. Assemble the caliper.
6. Install the caliper on the car.
7. Bleed the caliper.

Time on Job _______hrs.

Instructor's Initials ________

Auto Mechanics

No. D-3

OBJECTIVE: After completing this unit, the student will be able to rebuild the cylinder in a floating caliper disc brake unit.

EXPLANATION: These cylinders must be rebuilt if they are leaking and should be rebuilt each time that the pads are replaced.

MATERIALS NEEDED: Safety glasses, brake fluid, shop towels, caliper boots and seals

TOOLS NEEDED: "C" clamp, torque wrench, ratchet and socket wrench, screwdriver, wooden pick, pliers, 1/4" and 3/8" Allen wrench, cylinder hose

References	Do
#1. p. 29-28	#1. Read reference
#2. --	#2. Study information sheet
#3. pp. 524-526	
#4. pp. 448-450	
#5. p. 526	
#6. pp. 579-581	
#7.	
#8.	

No. D-3 Caliper Rebuild

Information Sheet # 2

Floating (sliding) Caliper

1. With the caliper removed from the vehicle, place it on a bench with the piston facing down. Place some shop towels below the piston and blow compressed air into the hydraulic fluid hole (Fig. D-72).

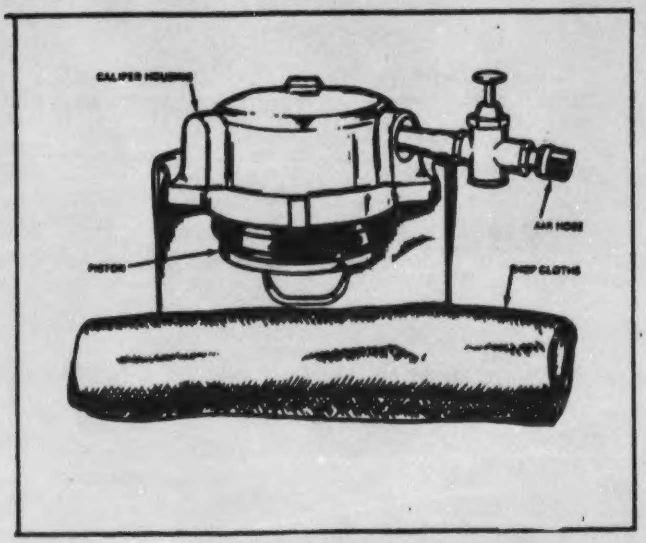

CALIPER HOUSING
AIR HOSE
PISTON
SHOP CLOTHS

Fig. D72 **Removing Piston**

Remove Dust Boot

2. Use a pointed wooden or plastic stick to work the piston seal out of the piston bore (Fig. D-73).

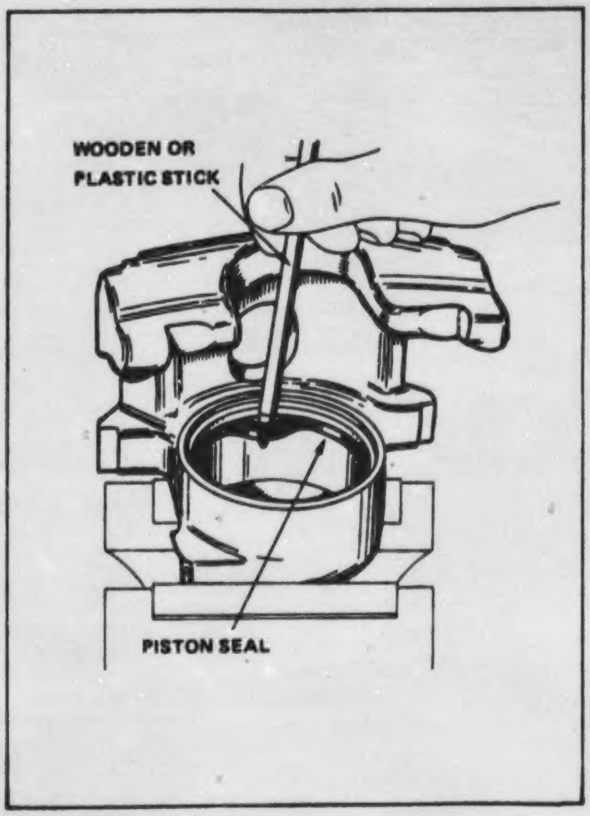

WOODEN OR
PLASTIC STICK
PISTON SEAL

Fig. D73 **Removing Piston Seal**

3. Clean caliper housing with clean brake fluid or isopropyl alcohol. Blow dry with filtered compressed air.

4. Lubricate piston seal and cylinder bore with clean brake fluid. Position the seal in the grove in the cylinder bore making sure that it is fully seated and not twisted.

5. Coat piston boot with brake fluid. Install the boot in the caliper using your fingers to work it into the outer groove (Fig. D-74). Slide forefinger around the inside of the boot to be sure that it is fully seated.

6. Plug caliper inlet and coat piston with lubricant.

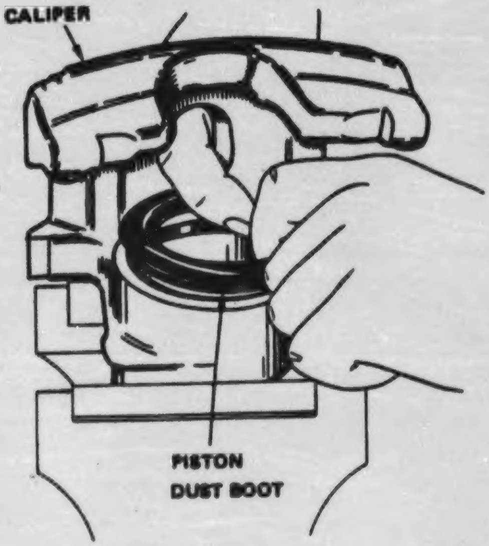


Fig. D74 Installing Boot

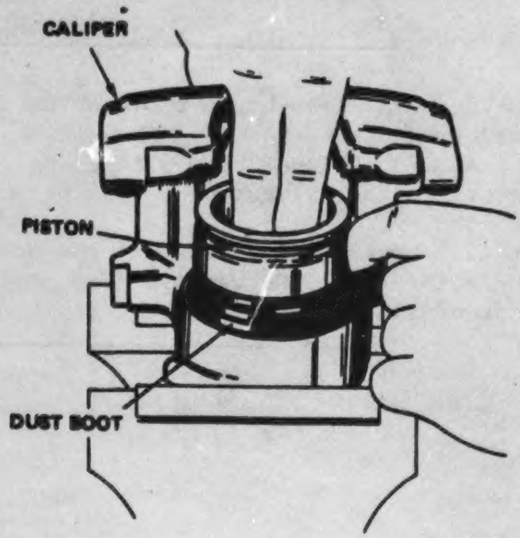


Fig. D- 75

7. With fingers spreading boot (Fig. D-75) work piston into boot and press down on piston. (The entrapped air below piston will force boot around piston and into its groove as piston is depressed).

8. Remove plug from caliper inlet and push piston down the bore until piston is bottomed.

9. Assemble other parts on the caliper and install the caliper and install the caliper as outlined under Pad and Plate Replacement.

10. Connect hydraulic hose to caliper inlet.

Bleeding and Checking

11. Fill master cylinder reservoirs and bleed hydraulic system.

12. After bleeding, depress brake pedal several times to seat pads on rotor.

WARINING: Do not move car until a firm brake pedal is obtained.

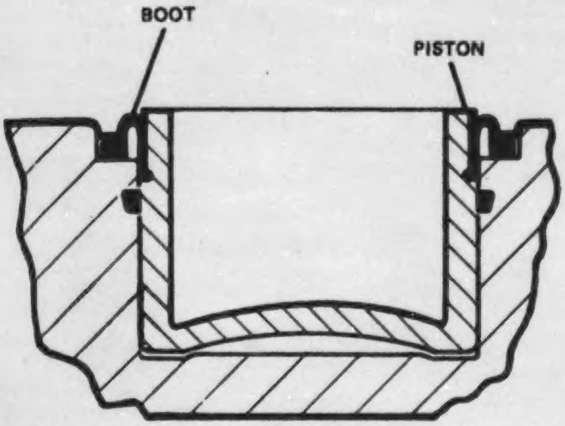


Fig.D-76 Installation of the piston boot.

Brakes - Disc Brake System and Service

No. D-3

Worksheet # 2

Name________________________________ Date________________ Grade_________

Overhaul A Delco-Moraine Caliper

Vehicle Identification Year ______ Make ______ Model ______

Flat Rate Time ________hrs.

1. Follow the steps in the Information Sheet and in the following general "Procedure Outline".
2. Check manufacturer's service manual for specific procedures, if necessary.

PROCEDURE OUTLINE

1. Remove the caliper from the car.
2. Disassemble the caliper.
3. Clean the parts.
4. Inspect the parts.
5. Assemble the caliper.
6. Install the caliper on the car.
7. Bleed the caliper.

Time on Job _______hrs.

Instructor's Initials_________

Auto Mechanics

No. D-4

OBJECTIVE: After completing this unit, the student will be able to:
Perform a visual inspection on rotor
check rotor runout, thickness, taper and parallelism

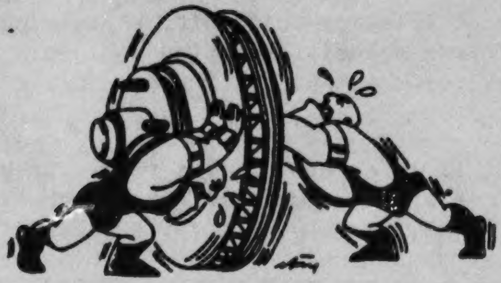
EXPLANATION: In order to determine if a rotor can be machined and put back in service you will have to check rotor runout, thickness, taper and parallelism and compare your findings with the manufacturers specifications.

MATERIALS NEEDED: Safety glasses

TOOLS NEEDED: Hand tools, micrometer, dial indicator and clamps

References		Do	
#1.	p. 29-30	#1.	Read reference
#2.	--	#2.	Study information sheets
#3.	pp. 537-539	#3.	Do worksheets # 1 and # 2
#4.	p. 441, pp. 447-451		
#5.	--		
#6.	--		
#7.	--		
#8.	--		

Information Sheet # 1



Introduction

Rotors are usually made of cast iron. In most instances, those used for front wheel brakes are integral, or in one piece, with their hubs. Rotors used for rear wheels do not have hubs. They are attached to flanges on the rear axles much the same as floating brake drums are attached. To obtain the advantages of a self-energizing brake in the parking brake system, some car makes incorporate a small brake drum into the rear-wheel rotors. Two small brake shoes expand inside the drum when the parking brake is applied. Thus, the parking brake is completely independent of the service brakes.

Like brake drums, rotors must be inspected for wear and damage. Visual inspection may disclose some of the more obvious defects. But a thorough inspection requires careful use of precision measuring instruments.

Inspection

Visual Insepction. You can usually perform a quick, visual inspection without removing the rotor. When the wheel is removed, the outer surface of the rotor is exposed. The inner surface may be concealed by the splash shield, but you can usually look between the rotor and its shield with the aid of a drop light or flashlight. In making a visual inspection you should look for two types of defects -- cracks and scoring.

Cracks. Any rotor exhibiting a crack should be replaced. Otherwise, it could fail and cause a serious accident.

Scoring: Scoring is the most obvious type of wear. The presence of light scoring on a rotor is no problem. Most manufacturers consider light scoring as a normal, acceptable wear pattern. Machining is required only when the scoring has caused a rough surface or when the grooves exceed o.o15 in. (0.39 mm) in depth. When you find a scored rotor. you should check the manufacturer's manual for recommendations.

Lateral Runout

To provide effective, safe braking, rotors must turn without excessive wobble. The surfaces on both sides of the rotor must be parallel, and those surfaces must be located so as to fall within the operating range of the caliper. Also, the thickness of the rotor must not be reduced too much by wear or machining. All manufacturers provide specifications covering these factors. In some instances they require that special measuring tool be used.

Rotor Runout: Excessive rotor runout is a common defect. Runout is a lateral, or side-to-side, movement of the rotor as it turns. This movement, or wobble, is caused by a warping and twisting of the rotor by the heat and pressures of braking. Rotor runout can be compared to brake drum out-of-round in that the rotor surface moves alternately toward and away from the lining. If the runout is excessive, it will push the shoes away from the rotor. This will increase the lining-to-rotor clearance causing the caliper piston to move back in its bore. When the brakes are applied, the piston must then move outward farther than normal. This, in turn, increases pedal travel. At times it also causes the pedal to pulsate, or bounce, as the shoes follow the wavy rotor surfaces (Fig. D-77).

Checking Rotor Runout: Before you can check for rotor runout, you must remove the wheel from the hub and all play from the wheel bearings. If the bearings are not adjusted to remove all play, the rotor can wobble on the spindle, and the actual runout cannot be accurately measured.

Rotor runout is measured with a dial indicator.

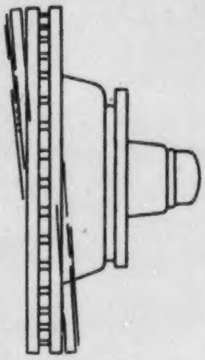


FIGURE D77—Excessive Runout—Disc Brakes

Here is the procedure you should use to measure rotor runout.

1. Raise and support the car.
2. Remove the wheel.
3. Adjust the wheel bearings to remove all play.
4. Mount the dial indicator on a solid surface such as the caliper, steering knuckle, or splash shield, as shown in Fig. D-78. Position the plunger so that is contacts the rotor surface about 1 in. (about 2.5 cm) from the edge.

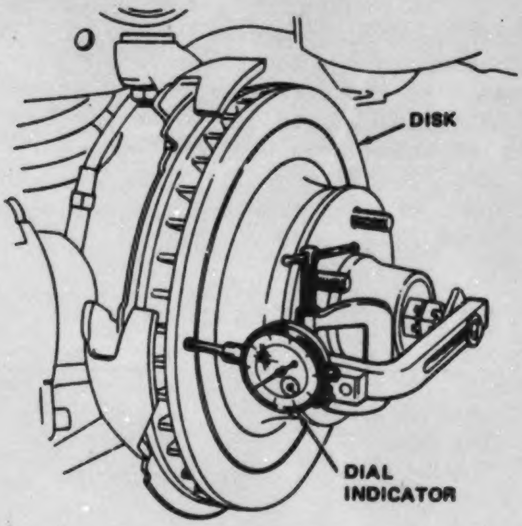


Fig. D-78

5. Turn the rotor one complete turn. Any runout will move the plunger and cause the pointer to move across the dial.
6. Record the total runout.

Note

Any runout that exceeds 0.005 inches (about 0.127 mm) is considered excessive. Since different manufacturers have different specifications, you should always check an oppropriate manual for this specification. A rotor with excessive runout should be machined or replaced.

Parallelism

The inner and outer surfaces of a rotor must be parallel to each other. Lack of parallelism is similar to runout in that it causes the pistons to be pushed back too far into their caliper bores. This defect is a common cause of vibration and pedal pulsation, and it should always be considered when those conditions exist.

Checking Rotor Parallelism: Rotor parallelism can be checked by several methods. One method is a continuation of the check for runout. It involves indicating the high and low areas on the rotor with chalk marks while checking runout. Position the dial indicator to measure the runout of the inner rotor surface. If the inner surface duplicates outer surface runout in reverse, the rotor surfaces are parallel. Any variation in measured runout means a rotor of varying thickness and thus a lack of parallelism. Another method of checking rotor parallelism is with a micrometer (Fig. D-79). "Mike" the thickness at four or more equally spaced points equi-distant from the outer edge of the rotor, preferably at mid-points of the braking surface. Parallelism, is the amount of variation between maximum and minimum measurements. If the rotor surfaces are parallel, all the measurements will be equal. Specifications for rotor parallelism are rather critical. Some manufacturers state that parallelism should be maintained to 0.0005 in. (about 0.0127 mm). Here too, you should consult the manufacturer's shop manual for the recommended procedure and specifications. Rotors that lack parallelism must be machined or replaced.

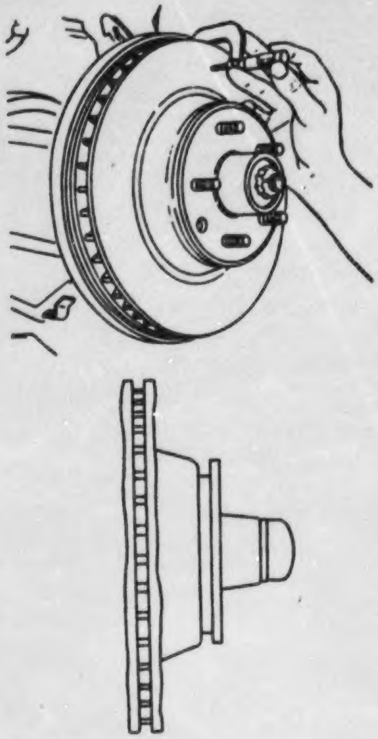


FIGURE D79-Rotor Parallelism—Disc Brakes

Taper Variation

Both surfaces of a rotor should be perfectly flat. Any taper wear exceeding the manufacturer's specifications causes the shoes to wear on an angle.

Checking Taper Variation

Taper variation is another condition you can check with a micrometer. You can combine this check with the checks for parallelism and thickness. Most manufacturers allow a taper variation of 0.002in. (about 0.091 mm). Even so, you should always consult the manual for the car you are working on. Fig. D-80 shows the spots you should measure. Measurements should be taken at several places around the rotor.

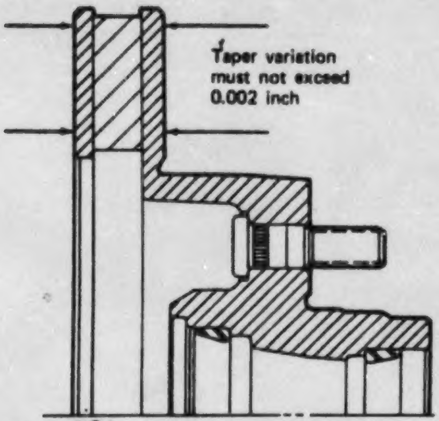


Figure D80 Sectional view of a rotor showing where measurements for taper variation should be taken (courtesy American Motors Corporation).

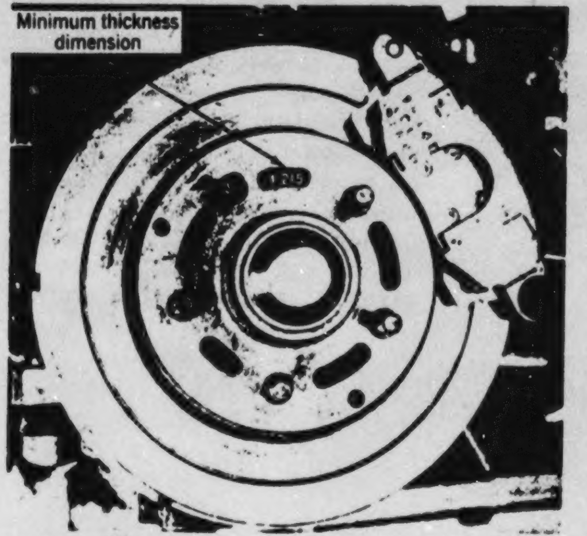


Figure D-81A rotor marked with its minimum thickness dimension (General Motors).

Minimum Thickness

Every rotor has a minimum thickness specification assigned by its manufacturer. Many rotors are marked with this dimension, as shown in Fig. D-81. This dimension is sometimes referred to as a discard dimension. Rotors that do not meet this specification should be discarded. This dimension is a wear dimension only. Under no circumstances should you ever machine a rotor to this dimension.

Checking Rotor Thickness

Rotor thickness, like rotor parallelism, is measured with a micrometer. Therefore, many mechanics combine the two operations. If the minimum thickness is not marked on the rotor, you will have to refer to the manufacturer's manual for the specification.

Inner Surface Stock Removal Limits

Since a rotor has two firctional surfaces, normal wear and any required machining may remove more stock, or material, from one side than from the other. Uneven wear is considered normal, and it is allowed within certain limits. Machining one side of a rotor more than the other side is also allowed, again within certain limits. Some manufacturers specify a limit on how much stock may be removed from the inner surface of their rotors. This limit is called the maximum allowable stock removal.

Checking for Excessive Stock Removal

Since this limit is established by each manufacturer for each different rotor design, special instruments are required for measuring it. Fig. D-82 shows one type of gauge set up to measure for excessive stock removal on a front hub and rotor. The reading, obtained on a special micrometer, is checked against a chart provided with the instrument. Any rotor not meeting specifications should be replaced.

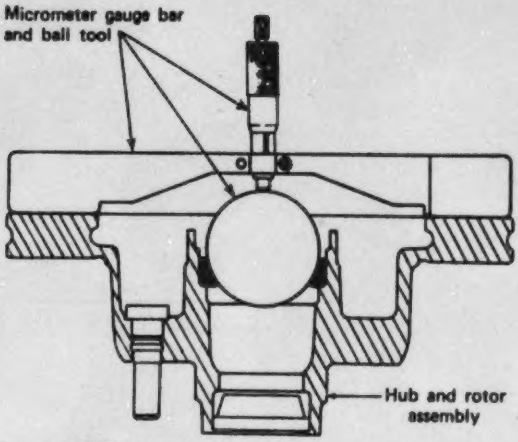


Figure D82 Measuring for excessive stock removal. Note the position of the special micrometer gauge bar and ball tool (Ford Motor Company).

Brakes - Disc Brake System and Service

No. D-4

Worksheet # 1

Name________________________________Date______________Grade________

Measuring Rotor Runout

Vehicle Identification Year ______ Make ______ Model ______

Flat Rate Time _______hrs.

1. Follow the steps in the Information Sheet and in the following general "Procedures Outline".

PROCEDURE OUTLINE

1. Raise and support the car.
2. Remove the wheel.
3. Eliminate play from the wheel bearing
4. Mount the dial indicator.
5. Check for runout.
6. Remove the dial indicator.
7. Adjust the wheel bearings.
8. Install the wheel and lower the car to the floor.

Time on Job _______hrs.

Instructor's Initials _______

Brakes - Disc Brake System and Service

No. D-4

Worksheet # 2

Name________________________________ Date_______________ Grade________

Measuring Rotor Thickness, Taper and Parallelism

Vehicle Identification Year _____ Make _____ Model _____

Flat Rate Time ______ hrs.

1. Read Information Sheet 1, p. 4.
2. Measure thickness, parallelism and taper. Record specifications (check specification at end of this section) and measurements on following blanks.

	SPECIFICATION	ACTUAL MEASUREMENT
Minimum Thickness Dimension	____________	________________
Taper Variation	____________	________________
Parallelism	____________	________________

Time on Job ______hrs.

Instructor's Initials _______

Auto Mechanics

No. D-4

OBJECTIVE: After completing this unit, the student will be able to machine a disc rotor properly.

EXPLANATION: If the rotor has lateral runout or has deep groove in it, it must be machined. If one rotor must be turned, the rotor on the other side of the car must be machined also in order to maintain the same friction.

MATERIALS NEEDED: Safety glasses, manual for brake lathe, specifications.

TOOLS NEEDED: Brake lathe, swirl grinder, dial indicator, micrometer.

References	Do
#1. --	#1. Read reference.
#2. --	#2. Study information sheet.
#3. --	#3. Do worksheet # 3.
#4. p. 450	
#5. p. 525	
#6. --	
#7.	
#8.	

Information Sheet # 2

ROTOR MACHINING

Rotor Lathes

The operating procedures for rotor lathes vary with the lathe design. Before using the lathe in your shop you should study the instruction manual furnished with it.

Two methods may be used to restore a rotor to specifications: (1) resurfacing and (2) reconditioning. The method you choose will depend on the condition of the rotor.

Resurfacing

A rotor can be resurfaced when its surfaces are rusted, contaminated with lining deposits, or lightly scored. Resurfacing consists of grinding the rotor surfaces with a sanding disc while the rotor is turning on a lathe. This operation is shown in Fig. D-83. Resurfacing removes very little material from the rotor, but it smoothes out minor imperfections.

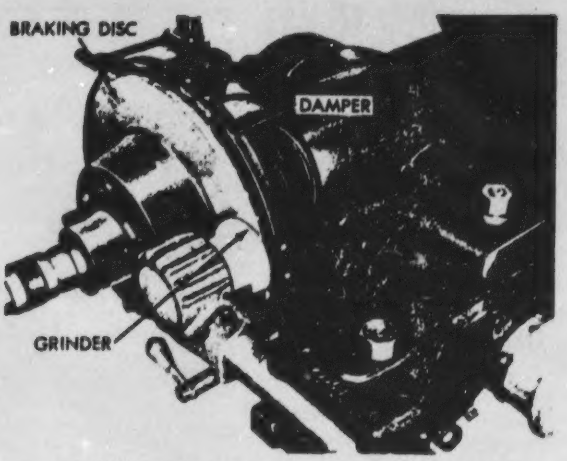


Figure D-83 Resurfacing a rotor. The grinder head is fitted with a sandpaper disc that spins rapidly while the rotor is turning (Chrysler Corporation).

Reconditioning

A rotor that lacks parallelism or has excessive runout, excessive taper variation, or deep scoring should be reconditioned. The procedure for reconditioning a rotor is similar to the procedure for reconditioning a brake drum. Cutting tools, or bits, are used for cutting away the surfaces of the rotor to eliminate defects. This operation is shown in Fig. D-84.

The specifications for rotors, however, are much more critical than the specifications for drums. Therefore, you must use extreme care in mounting a rotor on the lathe arbor. Rotors are mounted with the aid of adapters and cones in the same way that brake drums are mounted. When mounting a hubbed rotor, be sure tha adapters contact the bearing cups as shown in Fig. D- 85.

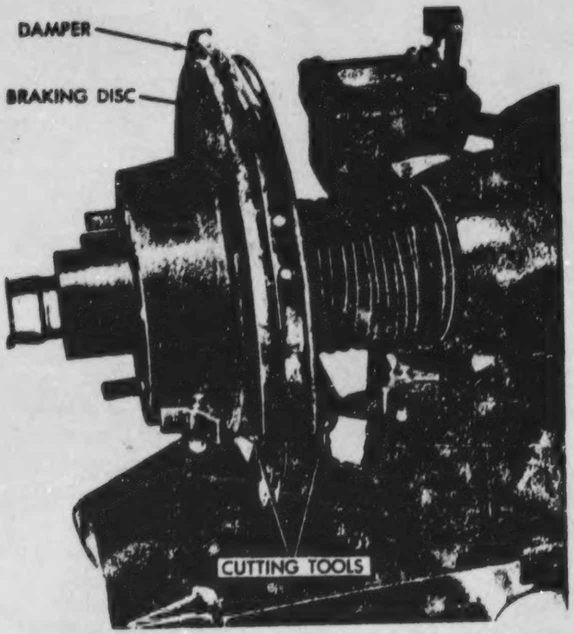

DAMPER
BRAKING DISC
CUTTING TOOLS

Figure D84 Reconditioning a rotor. The twin cutting tools remove material from both sides of the rotor at the same time (Chrysler Corporation).

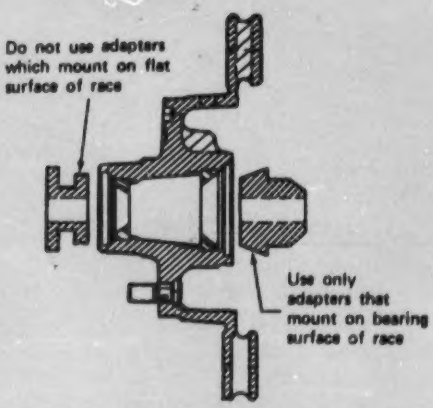

Do not use adapters which mount on flat surface of race
Use only adapters that mount on bearing surface of race

Figure D85 Selection of adaptors for mounting a rotor on a lathe arbor (General Motors).

Like drums, rotors will vibrate while you are machining them. Their vibration can prevent you from obtaining the desired finish on the rotor surfaces. For this reason, these vibrations must be dampened out. Always install a thin rubber dampening belt on a rotor before you machine it. Refer to Fig. D-86 for the correct way to install the belt.

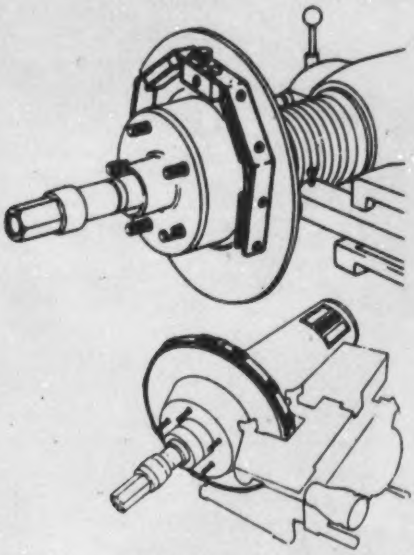


Fig. D86 Silencers for disk rotors when machining rotor faces. (*Ammo Tools, Inc.*)

The finish on the rotor surfaces must fall within a certain range of smoothness and must be nondirectional. This requires that any rotor that is reconditioned also be resurfaced. Most manufacturers specity a finish of between 20 and 60 microinches. This finish cannot be measured with the instruments available in the average shop. It can be obtained, however, by the proper selection of the sanding disc used on the grinder. You should check the instruction manual for the lathe you are using to determine the proper grade of sandpaper. Grinding the disc after it has been reconditioned will provide a nondirectional finish, as shown in Fig. D-87.

Figure D87 A rotor after resurfacing. Note the desired nondirectional pattern on the surface (courtesy American Motors Corporation).

Brakes - Disc Brake System and Service

No. D-4

Worksheet # 3

Name________________________________Date_______________Grade________

Machine A Disc Brake Rotor

Vehicle Identification   Year ______ Make ______ Model ______

Flat Rate Time ______hrs.

1. Read Information Sheet 2, pp. 1-3.
2. Follow the steps in the following general "Procedure Outline" in addition to the lathe manufactures operating sheet.

PROCEDURE OUTLINE

Minimum Thickness ___________________(Cast on rotor)

Actual Thickness ____________________

(Check specifications at end of this section)

1. Select the correct adapters.
2. Mount the rotor on the lathe arbor.
3. Adjust the rotor position to obtain minimum runout.
4. Cut both sides of the rotor to eliminate defects.
5. Grind the rotor surfaces to obtain a smooth nondirectional pattern.
6. Check the minimum thickness dimension.

Time on Job ______hrs.

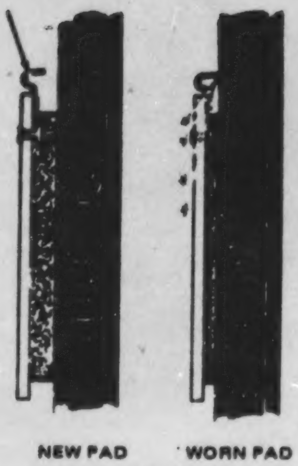
Instructor's Initials _______

Brakes - Disc Brake System and Service

No. D-4

Final Test

Name____ **Date**______________ **Grade**_______



1. The arrow in the picture above is pointing to:

   a. An anti-rattle clip
   b. A stabilizer
   c. An anchor plate
   d. A wear indicator

2. Disc brakes use no residual pressure check valve because:

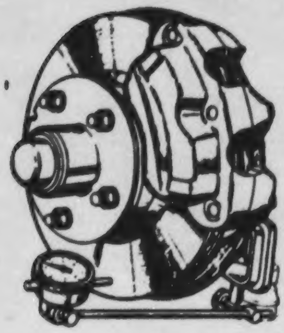
   a. Disc brakes use a metering valve
   b. Residual pressure would cause dragging of brakes
   c. Residual pressure would delay front brake application
   d. Disc brakes use a proportioning valve

3. Prior to replacing disc brake pads, remove some of the brake fluid from the master cylinder reservoir that feeds the disc brakes. This will:

   a. Make bleeding easier
   b. Prevent fluid overflow when the pistons are pushed back into the calipers
   c. Allow pressure to the front and rear axles to equalize
   d. Prevent the brake warning light from coming on

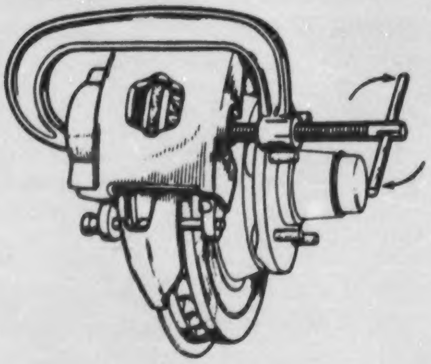
4. Some cars with front disc brakes use a metering valve. When bleeding this type of brake with a pressure tank, which of the following apply?

a. The metering valve plunger must be pushed to the closed position.
b. The metering valve has no effect on bleeding brakes if a diaphragm type pressure tank is used.
c. The metering valve plunger must be held in the open position.
d. Both a and b above.



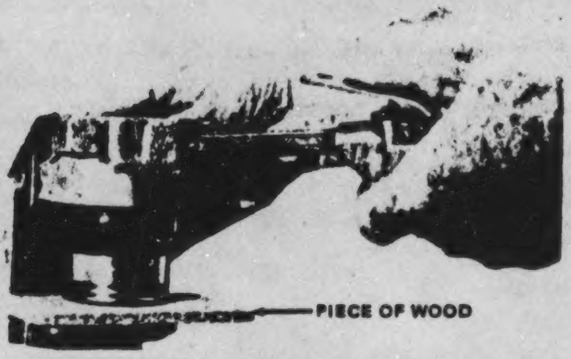
5. When making the above pictured t.i.r. check, which of the following readings would be considered maximum?

a. 0.010"
b. 0.002"
c. 0.0005"
d. 0.005"



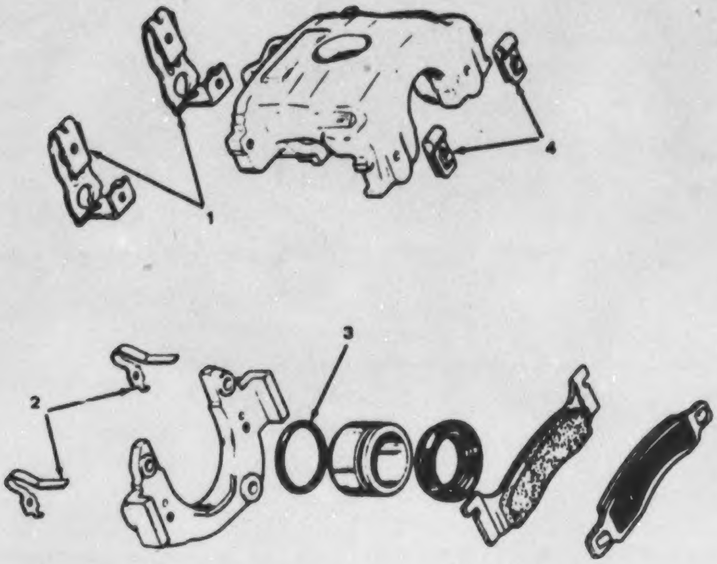
6. The above illustration shows the:

a. Caliper mounting pin being pressed out
b. Caliper piston being pushed into its bore
c. Outboard shoe being attached to the caliper
d. Outer shoe ears being crimped



7. The above illustration shows the:

a. Caliper-to-piston-bore clearance being checked
b. Piston being removed from caliper
c. Dust boot and piston being installed
d. Square-cut seal being removed



8. Refer to the above disc brake exploded view illustration. Which arrow is pointing to the part(s) responsible for the self-adjusting action?

a. #1
b. #2
c. #3
d. #4

9. The disc brake reservoir portion of a dual master cylinder is low on fluid.

Mechanic A says the brake pads may be worn.

Mechanic B says the power brake booster may be faulty.

Who is right?

a. A only
b. B only
c. Both A and B
d. Neither A nor B

10. Mechanic A says that master cylinders used on a disc/drum combination system have a smaller reservoir for the front disc brakes than they do for the rear drum brakes.

Mechanic B says that the disc brake rotors in a combination system have a lower pressure requirement than the rear drums.

Who is right?

a. Mechanic A
b. Mechanic B
c. Both A and B
d. Neither A nor B

11. On a front disc brake vehicle, violent cornering or rough roads may cause:

a. A drop in fluid pressure
b. Excessive pedal travel
c. Both a and b
c. Neither a nor b

12. The most common type of disc brake caliper found on American cars since 1969 is the:

a. Single piston sliding
b. Two piston fixed
c. Two piston sliding
d. Four piston fixed

13. To check rotor parallelism you use a:

a. Straight-edge
b. Micrometer
c. Dial indicator
d. Special service tool

14. A vehicle is equipped with power disc brakes. The owner says that in order to stop the car excessive pedal effort is required.

Mechanic A says that a master cylinder or power brake malfunction could be the reason.

Mechanic B says that air in the hydraulic system is probably the cause.

Who is right?

a. Mechanic A
b. Mechanic B
c. Both A and B
d. Neither A nor B

15. The brake pedal on a car with disc/drum brakes pulsates up and down when the brakes are applied. The most probable cause would be:

a. Worn brake pads
b. Rotor with excessive lateral runout
c. Plugged compensations port in the master cylinder
d. Frozen piston in a caliper

No. D-5 Disc Brake Specifications

Information Sheet # 1

Disc Brake Specifications

F.M.S.I. Numbers Set Forth Herein are the Property of and are Copyrighted by Friction Materials Standards Institute, Paramus, N J

F—Front
R—Rear

T.I.R.—Total Indicator Reading.
T.I.R.—one revolution

U—Upper
L—Lower

S,L—Small, Large
NS—Not Serviceable

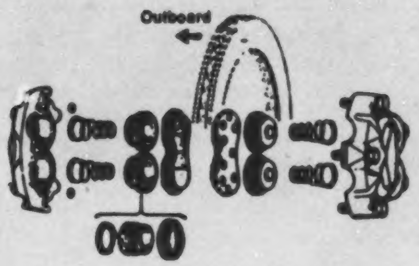
ƒ'—Pound-feet
ƒ''—Pound-inches

ILLUSTRATION	1 APPLICATION	2 DISC PAD		3 ROTOR				4 HI-TENSILE BOLT (NUT) TORQUE		
				Minimum Thickness						
	19.. Make & Model	Pad Set Ref. No.	Minimum Lining Thickness	Machine To	Discard at	Parallelism lack-of	Lat'l runout T.I.R.	Caliper and/or Bracket Mounting	Caliper Bridge or Guide Bolt, Pin, or Key Screw	Wheel Nut Rotor to Hub Nut
	AMERICAN MOTORS GROUP **All Passenger cars except Jeep models:**									
R	78 GREMLIN 4 cyl	7026	.062	0.81	.0805	.0005	.003	80	15	75
R	78-77 All except 4-cyl Gremlin and All Matador	7027	.062	0.81	.0805	.0005	.003	80	15	75
R	78-Late 77 Matador	7056E	.062	1.12	1.115	.0005	.003	80	15	75
R	Early 77-75 Matador	7056E	.062	1.12	1.115	.0005	.003	80	15	75
R	76-74 w/Bendix caliper	7056E	.062	1.12	1.115	.0005	.003	80	15	75
I	76-71 w/"A" caliper	781	.062	.955	.940	.0005	.005	85S-105L	30-35	75
A	70-69 10-80 8 cyl	731	.062	.465	.450	.0005	.005	85	100-110	75
A	70-69 10-80 6 cyl	731	.062	.465	.450	.0005	.005	85	100-110	75
A	70-69 01-30-70	731	.062	.465	.450	.0005	.005	85	100-110	75
	JEEP—Including Wagoneer, Cherokee, and Pickups									
R	78-77 CJ	7056E	.030	1.12	1.115	.001	.005	—	15	75
J	78-74 All except CJ	728A	.030	1.23	1.215	.001	.005	120U/70L	35	75*
		*J20 (8400 GVW) torque to 130 ft.lbs.								
	CHECKER MOTORS									
J	78-76	728A	.030	1.230	1.215	.0005	.004	125	35	95-110
J	75-71	728A	.030	1.230	1.215	.0005	.005	110-140U/ 90-103L	40	95-110
J	70-69	728A	.030	1.230	1.215	.0005	.004	125U/98-103L	35	75
	CHRYSLER MOTORS GROUP—Chrysler, Dodge, Plymouth, Dodge & Plymouth Trucks **Full-size—Chrysler Newport, New Yorker Town and Country, 300 (71-67)** **Dodge Monaco, Polara (73-67)** **Plymouth Fury (74-67), Gran Fury (75), GT, Suburban SW, V.I.P.**									
O	78-76	7019	.030	1.195	1.180	.0005	.004	95-125	15	85
O	75-74	7019	.030	1.195	1.180	.0005	.004	85	15	65
I	73	7018	.030	1.195	1.180	.0005	.0025	75-100	30-35	65
I	72	781	.030	1.195	1.180	.0005	.0025	75-100	30-35	65
I	71-69	781	.030	1.195	1.180	.0005	.0025	75-100	30-35	65
B	68-67	732	.030	.844	.829	.0005	.005	80-90	7/16-55, 5/8-150	65*
		*60-90 rotor to hub								
	Chrysler Imperial:									
O	75-74 Front	7019	.030	1.195	1.180	.0005	.004	85	15	65
	Rear	7029	.030	955	.940	.0005	.004	85	15	65
I	73	7018	.030	1.195	1.180	.0005	.0025	75-100	30-35	65
I	72	781	.030	1.195	1.180	.0005	.0025	75-100	30-35	65
I	71-70	781	.030	1.195	1.180	.0005	.0025	75-100	30-35	65
B	69-67	732	.030	.844	.829	.0005	.005	80-90	7/16-55, 5/8-150	65*
		*60-90 rotor to hub								

5 HYDRAULIC VALVES		6 WHEEL BEARING ADJUSTMENT		
		Step 1	Step 2	Step 3
Metering Front	Proportion Rear	Torque Spindle Nut	Back-off and Retorque	Lock or Back-off and lock Min./Max.
no	yes	25#'	6#"	step 2
no	no	25#'	6#"	step 2
no	no	25#'	6#"	step 2
yes	no	25#'	6#"	step 2
yes	no	22#'	6#"	step 2
yes	yes	22#'	6#"	step 2
no	yes	20#'	12#"	step 2
no	no	20#'	12#"	step 2
no	yes	20#'	12#"	step 2
yes	yes	50#'	skip	¼ turn
yes	yes	50#'	skip	¼ turn
yes	yes	10-16#'	2#'	to slot
yes	yes	10-16#'	2#'	to slot
yes	yes	snug-up	handtight	to slot
yes	yes	240-300#"	handtight	step 2
yes	yes ex. SW	90#"	skip	1 slot
yes	yes ex. SW	90#"	skip	1 slot
yes	yes ex. SW	90#"	skip	1 slot
yes	no	90#"	skip	1 slot
yes	no	90#"	skip	1 slot
yes	—	90#"	skip	1 slot
—	yes	—	—	—
yes	yes	90#"	skip	1 slot
yes	yes	90#"	skip	1 slot
yes	no	90#"	skip	1 slot
yes	no	90#"	skip	1 slot

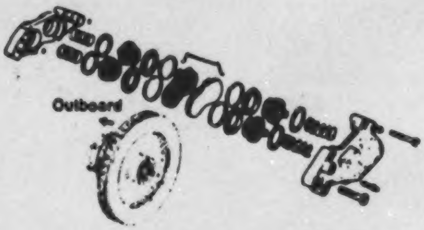
ILLUSTRATIONS

Ⓐ FIXED CALIPER



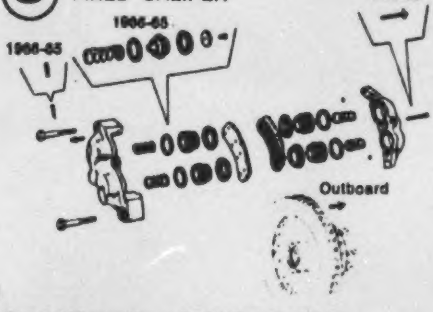
Amer. Mtrs. 70-65 • Buick 68-67 • Dodge-Plymouth 68-67

Ⓑ FIXED CALIPER



Chrysler Group Full-size cars 68-66, Imperial 68-67

Ⓒ FIXED CALIPER



General Motors Group 68-67, Corvette 78-65

F—Front
R—Rear

T.I.R.—Total Indicator Reading.
T.I.R.—one revolution

U—Upper
L—Lower

S,L—Small. Large
NS—Not Serviceable

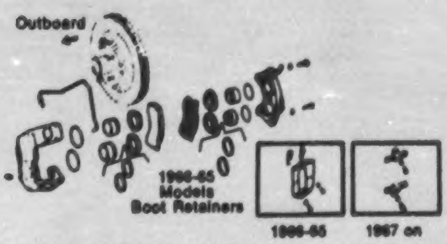
#'—Pound-feet
#"—Pound-inches

ILLUSTRATION	1 APPLICATION	2 DISC PAD		3 ROTOR				4 HI-TENSILE BOLT (NUT) TORQUE		
				Minimum Thickness						
	19.. Make & Model	Pad Set Ref. No.	Minimum Lining Thickness	Machine To	Discard at	Parallelism lack-of	Lat'l runout T.I.R.	Caliper and/or Bracket Mounting	Caliper Bridge or Guide Bolt, Pin, or Key Screw	Wheel Nut Rotor to Hub Nut
	CHRYSLER MOTORS GROUP CONTINUED **Intermediates—Chrysler Cordoba:** **Dodge Charger, Coronet, Super Bee (71-68)** **Plymouth Belvedere/Satellite (74-68), Fury (75), GTX (71), Road Runner, Suburban SW:**									
I	78-76 w/Pin caliper	7018	.030	.955	.940	.0005	.004	95-125	25-40	85
O	w/Slider caliper	7017	.030	.955	.940	.0005	.004	95-125	15	85
I	75-73 w/Pin caliper	7018	.030	.955	.940	.0005	.0025	75-100	30-35	65
O	74 w/Slider caliper	7017	030	.955	.940	.0005	.004	85	15	65
I	72	781	.030	.955	.940	.0005	.0025	75-100	30-35	65
I	71-70	781	.030	.955	.940	.0005	.0025	75-100	30-35	65
A	69-67	751	.030	.831	.816	.0005	.005	85-90	120-140	55-65
	Compacts—Dodge Dart, Demon (72-71), Swinger: **Plymouth Valiant/Duster, Scamp, Aspen, Volare**									
O	78-76	7017	.030	.955	.940	.0005	.004	95-125	15	85
O	75-73	7017	.030	.955	.940	.0005	.004	85	15	55
D	72-65	730	.030	.790	.780	.0005	.0025	50-80	70-80	55
	Omni, Horizon									
X	78	7074	.030	.970	.940	.0005	.004	95-125	25-40	85
	Dodge Challenger (74-70) **Plymouth Barracuda (74-65), Cuda (74-69)**									
I	74-73	7018	.030	.955	.940	.0005	.0025	75-100	30-35	65
I	72-70	781	.030	.955	.940	.0005	.0025	75-100	30-35	65
D	69-65	730	.030	.790	.780	.0005	.0025	50-80	70-80	55
	Sport Utility—Dodge Tk. Ramcharger: **Plymouth Trail Duster:**									
O	78-74 4 x 2	7019	.030	1.22	1.19	.0005	.004	95	17	85-125
O	78-74 4 x 4	7019	.030	1.22	1.19	.0005	.004	95	17	85-125
	Compact Van, Wagon—Dodge Tk., Sportsman, Tradesman: ½ Ton ("B100") **Plymouth, Voyager: ½ Ton (PB100)** **Dodge Tk. D100 ½ Ton:**									
O	78-75	7019	.030	1.22	1.19	.0005	.004	95-125	14-22	85-125
O	74-73	7019	.030	1.22	1.19	.0005	.004	75-100	14-22	68-85
I	72-71	781	.030	1.20	1.18	.0005	0025	75-100	30-35	65-75
	FORD MOTORS GROUP—Ford, Lincoln, Mercury, Ford Truck **Full-size—Ford Custom, Galaxie, LTD, XL (70-68), Country Sedan-Squire, Ranch Wagon:** **Mercury Marquis, Monterey, Colony Park, Monclair (68), Parklane (69-68), Meteor (Canada):**									
R	78-73 Front	7056A	.030	—	1.120	.0005	.003	90-120	12-16	70-115
S	78-75 Rear w/disc	7038A	030	—	.895	.0005	.004	90-120	12-16	70-115
L	72-70	773	.030	1.135	1.120	.0007	.003	U. 110-140 L. 90-120	25-35	70-115
L	69	773	.030	1.135	1.120	.0007	.003		25-35	70-115
L	68	773	.030	1.135	1.120	.0007	.003	U. 110-120 L. 90-120	25-35	70-115

5 HYDRAULIC VALVES		6 WHEEL BEARING ADJUSTMENT		
		Step 1	Step 2	Step 3
Metering Front	Proportion Rear	Torque Spindle Nut	Back-off and Retorque	Lock or Back-off and lock Min./Max.
yes	yes	240-300#'	handtight	step 2
yes	yes	240-300#'	handtight	step 2
yes	yes ex. SW	90#'	skip	1 slot
yes	yes ex. SW	90#'	skip	1 slot
yes	yes ex. SW	90#'	skip	1 slot
yes	yes	90#'	skip	1 slot
no	yes	90#'	skip	1 slot
yes	yes	240-300#'	handtight	step 2
no	yes	70#'	skip	1 slot
no	yes	70#'	skip	1 slot
no	no	240-300#'	handtight	step 2
yes	yes	90#'	skip	1 slot
yes	yes	90#'	skip	1 slot
no	yes	70#'	skip	1 slot
yes	no	90#'	skip	1 slot
yes	no	—	—	—
yes	no*	90-120#'	handtight	step 2
yes	no	90-120#'	handtight	step 2
no	yes ex D100	90#'	handtight	step 2
*78 D100 & W100 use a proportioning valve				
some	yes	17-25#'	10-15#'	step 2
no	yes	—	—	—
yes	yes	17-25#'	10-15#'	step 2
no	yes	17-25#'	10-15#'	step 2
no	yes	17-25#'	10-15#'	step 2

ILLUSTRATIONS

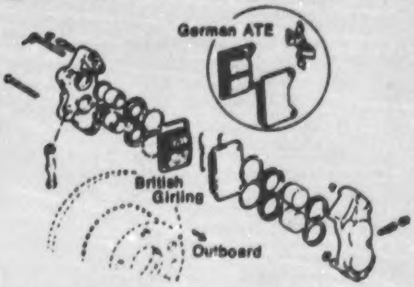
Ⓓ FIXED CALIPER



El Dorado 66-67 • Chrysler Group Compacts 72-65
• Ford Motor Group 67-65, Lincoln 72-65
• Toronado 66-67

Ⓔ FIXED CALIPER

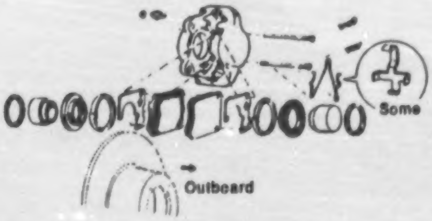
Do not separate caliper halves.



English Girling • German ATE • Volvo, front

Ⓕ FIXED CALIPER

Do not separate caliper halves.



English Girling • Japanese • Capri • Colt • Cricket
• Datsun 240-260-1200 • Toyota Corona Mk. II
• Volvo, rear

F—Front
R—Rear

T.I.R.—Total Indicator Reading.
T.I.R.—one revolution

U—Upper
L—Lower

S,L—Small, Large
NS—Not Serviceable

#' Pound-feet
#" Pound-inches

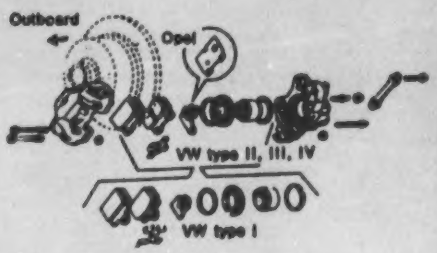
ILLUSTRATION	1 APPLICATION	2 DISC PAD		3 ROTOR				4 HI-TENSILE BOLT (NUT) TORQUE		
				Minimum Thickness						
	19.. Make & Model	Pad Set Ref. No.	Minimum Lining Thickness	Machine To	Discard at	Parallelism lack-of	Lat'l runout T.I.R.	Caliper and/or Bracket Mounting	Caliper Bridge or Guide Bolt, Pin, or Key Screw	Wheel Nut Rotor to Hub Nut
	FORD MOTORS GROUP CONTINUED **Lincoln:**									
R	78-73 Front	7056A	.030	—	1.120	.0005	.003	90-120	12-16	70-115
S	78-75 w/rear disc	7038A	.030	—	.895	.0004	.004	90-120	12-16	70-115
L	72-70	773	.030	1.135	1.120	.0007	.003	U, 110-140 L, 90-120	25-35	70-115
D	69-68	726	.067	1.230	1.215	.0007	.002	110-140	75-105	75-115
	Ford—Thunderbird: **Lincoln—Mark III, Mark IV, V**									
R	78-73 Front	7056A	.030	—	1.120	.00025	.003	90-120	12-16	70-115
S	78-75 w/Rear disc	7038A	.030	—	.895	.0004	.004	90-120	12-16	70-115
R	72	7056A	.030	1.135	1.120	.0005	.003	90-120	12-16	70-115
L	71-70	773	.030	1.135	1.120	.0007	.003	U, 110-140 L 90-120	25-35	70-115
L	69	773	.030	1.135	1.120	.0007	.003		25-35	70-115
L	68 T'bird	773	.030	1.135	1.120	.0007	.003	U, 110-120 L, 90-120	25-35	70-115
	Intermediates—Ford Elite Fairlane (70-68), Torino, Cobra (71-70), GT (71-70), Ranchero, Ranch Wagon, Squire, LTD II: **Mercury Montego, CJ (69), Cyclone (71-68), GT (73-68), MX, Spoiler (71-70), Villager SW, Cougar (78-74):**									
R	78-72	7056A	.030	—	1.120	.0005	.003	90-120	12-16	70-115
L	71-68	776	.030	.890	.875	.0007	.002	U, 110-140 L, 55-75	25-35	70-115
	Compacts—Ford Falcon (70-68), Granada, Maverick: **Mercury Comet, Monarch, Lincoln Versailles:**									
R	78-76 Front	7027	.030	—	.810	.0005	.003	U, 90-120 L, 55-75	12-16	70-115
S	78-76 Granada, Monarch w/rear disc	7038A	.030	—	.895	.0005	.003	90-120	12-16	70-115
R	75-74	7027	.030	.825	.810	.0005	.003	—	—	70-115
L	70-68	776	.030	.890	.875	.0007	.002	U, 110-140 L, 55-75	25-35	70-115
	Ford Mustang (73-68), Mach 1 (73-69): **Mercury Cougar, XR7:**									
R	78-74	7056A	.030	—	1.120	.0005	.003	90-120	12-16	70-115
L	73-68	776	.030	.890	.875	.0007	.002	U, 110-140 L, 55-75	25-35	70-115
	Fairmont Zephyr									
W	78	7072	.030	—	.810	.0005	.003	—	30-40	70-115
	Sub-Compacts—Ford Mustang II (78-74) Pinto: **Mercury Bobcat:**									
R	78-76	7026	.030	—	.810	.0005	.003	U90-120 L55-75	12-16	70-115
R	75-74	7026	.030	825	.810	.0005	.003	—	—	70-115
Q	73-71	779	.030	700	.685	.0007	.003	U, 90-120 L, 55-75	—	70-115

5		6		
HYDRAULIC VALVES		WHEEL BEARING ADJUSTMENT		
		Step 1	Step 2	Step 3
Metering Front	Proportion Rear	Torque Spindle Nut	Back-off and Retorque	Lock or Back-off and lock Min./Max.
some	yes	17-25#'	10-15#'	step 2
no	yes	—	—	—
yes	yes	17-25#'	10-15#'	step 2
yes	yes	17-25#'	10-15#'	step 2
some	yes	17-25#'	10-15#'	step 2
no	yes	—	—	—
yes	yes	17-25#'	10-15#'	step 2
yes	yes	17-25#'	10-15#'	step 2
no	yes	17-25#'	10-15#'	step 2
no	yes	1725#'	10-15#'	step 2
yes	yes	17-25#'	10-15#'	step 2
no	yes	17-25#'	10-15#'	step 2
no	yes	17-25#'	10-15#'	step 2
no	yes	17-25#'	10-15#'	step 2
no	yes	17-25#'	10-15#'	step 2
no	yes	17-25#'	10-15#'	step 2
yes	yes	17-25#'	10-15#'	step 2
no	yes	17-25#'	10-15#'	step 2
no	yes	17-25#'	10-15#'	step 2
no	yes	17-25#'	10-15#'	step 2
no	yes	17-25#'	10-15#'	step 2
no	yes	17-25#'	10-15#'	step 2

ILLUSTRATIONS

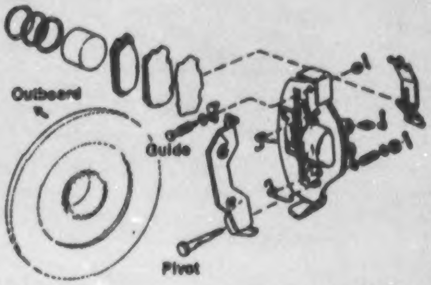
(G) FIXED CALIPER

Do not seperate caliper halves.


Outboard
Opel
VW type II, III, IV
VW type I

German ATE • Opel • Volkswagen • Volvo, rear

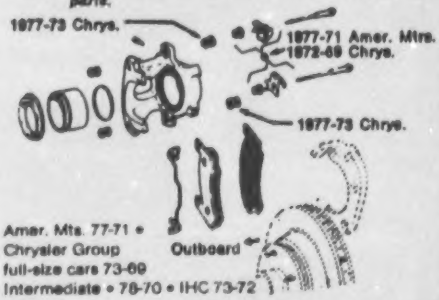
(H) PIVOT FLOAT CALIPER


Outboard
Guide
Pivot

English Lockheed • Japanese • Datsun 411-510-610-710

(I) FLOATING CALIPER

When installing new pads use new aligning parts.


1977-73 Chrys.
1977-71 Amer. Mtrs.
1972-69 Chrys.
1977-73 Chrys.
Outboard

Amer. Mts. 77-71 •
Chrysler Group
full-size cars 73-69
Intermediate • 78-70 • IHC 73-72

F—Front
R—Rear

T.I.R.—Total Indicator Reading.
T.I.R.—one revolution

U—Upper
L—Lower

S,L—Small, Large
NS—Not Serviceable

#'—Pound-feet
#"—Pound-inches

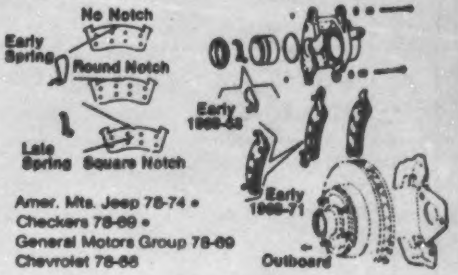
ILLUSTRATION	1 APPLICATION	2 DISC PAD		3 ROTOR				4 HI-TENSILE BOLT (NUT) TORQUE		
	19.. Make & Model	Pad Set Ref. No.	Minimum Lining Thickness	Minimum Thickness		Parallelism lack-of	Lat'l runout T.I.R.	Caliper and/or Bracket Mounting	Caliper Bridge or Guide Bolt, Pin, or Key Screw	Wheel Nut Rotor to Hub Nut
				Machine To	Discard at					
	FORD MOTORS GROUP CONTINUED **Fiesta**									
Q	78	7064	—	—	.034	—	.006	—	38-45	52-74
	Ford Tk.—Ranchero, see Torino: **100/150, E, 78-75; F 78-75** **250, F std. 6200 GVW (78-73): Bronco 78-76, E 75**									
R	78-76	7056A	.030	1.145	1.120	.0007①	.003②	—	12-20	70-115
R	75-73	7056A	.067	1.135	1.120	.0003	.003	90-120	12-18	70-115
		①.001 with separate H & disc ②.005 w/sep. H & disc								
	Ford Tk.—250, F HD 6200 thru 8100 GVW: E 78-7 **350, E, F:**									
U	78-76	7054	.030	—	1.18	.0007①	.003②	74-102	12-20	70-135③
M	75-68	771	.067	.955	.940	.001	.003	55-75* *115-185 hyd. cyl.	17-23	1/2, 70-115 9/16, 125-175
		①.001 w/sep. H & disc ②.005 w/sep. H & disc ③w/dual rear wheels 210#'								
	GENERAL MOTORS GROUP—Buick, Cadillac, Chevrolet, Oldsmobile, Pontiac, Chevrolet & GMC Trucks **BUICK Fullsize—Centurion, Electra, Estate Wagon, Le Sabre, Riviera, Wild Cat:**									
J	78-77	728A	.020	.980	.965	.0005	.005	—	30-40	80-100
	w/Rear disc	728E	.020	.980	.965	.0005	.005	—	30-40	100
	76-71	728A	.020	1.230	1.215	.0005	.005	—	30-40	75
J	70	728A	.020	1.230	1.215	.0005	.004	—	30-40	75
A	69-68	772	.020	.980	.965	.0005	.005	70-90	125	65
	Intermediates—Century, GS Grand Sport, Regal, Skylark (72-67), Special (70-67), Sportswagon:									
J	78-76	728A	.020	.980	.965	.0005	.004	125	35	70-80
J	75-71	728A	.020	.980	.965	.0005	.004	—	35	65-70
J	70-69	728A	.020	.980	.965	.0005	.004	—	35	65-70
C	68-67	762	.020	.980	.965	.0005	.004	75	130	65-70
	Compacts—Apollo, Skylark:									
J	78-76	728A	.020	.980	.965	.0005	.005	125	35	70-80
J	75-73	728A	.020	.980	.965	.0005	.004	—	35	65-70
	Sub-Compact—Skyhawk:									
K	78-76	7053	.030	.830	.815	.0005	.005	—	—	80
K	75	778	.030	.455	.440	.0005	.005	—	—	65

5 HYDRAULIC VALVES		6 WHEEL BEARING ADJUSTMENT		
		Step 1	Step 2	Step 3
Metering Front	Proportion Rear	Torque Spindle Nut	Back-off and Retorque	Lock or Back-off and lock Min./Max.
no	no	front drive		
yes	yes	17-25#'	10-15#"	step 2
no	yes	17-25#'	10-15#"	step 2
yes	yes	17-25#'	10-15#"	step 2
yes	no	17-25#'	skip	2 slots
yes	yes	12#'	handtight	½ flat
yes	yes	—	—	—
yes	yes	12#'	handtight	⅓ flat
yes	no	19#'	11#'	1 slot/ ¼ turn
yes	no	19#'	11#'	1 slot/ ¼ turn
yes	yes	12#'	handtight	⅓ flat
yes	yes	19#'	11#'	1 slot/ ¼ turn
yes	no	19#'	11#'	1 slot/ ¼ turn
yes	no	19#'	11#'	1 slot/ ¼ turn
yes	yes	12#'	handtight	½ flat
yes	no	19#'	11#'	1 slot/ ¼ turn
yes	yes	12#'	handtight	½ flat
no	no	12#'	skip	1 nut flat

ILLUSTRATIONS

Ⓙ FLOATING CALIPER

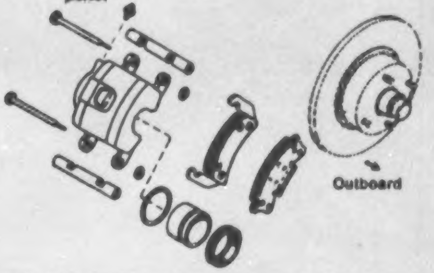
When installing new pads use new aligning parts. Earlier parts shown are replaced with the later design.


No Notch
Early Spring
Round Notch
Early
Late Spring
Square Notch
Early 1969-71
Outboard

Amer. Mts. Jeep 78-74 •
Checkers 78-69 •
General Motors Group 78-69
Chevrolet 78-66

Ⓚ FLOATING CALIPER

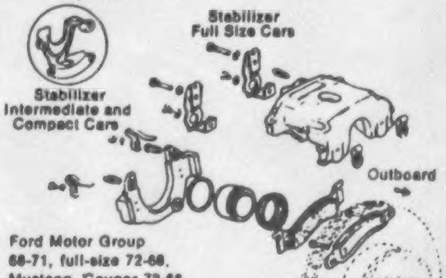
When installing new pads use new aligning parts.



General Motors Group Sub-compacts 75, Vega 78-71

Ⓛ FLOATING CALIPER

When installing new pads use new aligning parts.


Stabilizer Full Size Cars
Stabilizer Intermediate and Compact Cars
Outboard

Ford Motor Group
68-71, full-size 72-68,
Mustang, Cougar 73-68

F—Front
R—Rear

T.I.R.—Total Indicator Reading.
T.I.R.—one revolution

U—Upper
L—Lower

S,L—Small, Large
NS—Not Serviceable

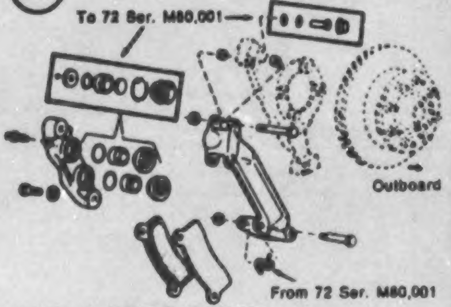
—Pound-feet
#'—Pound-inches

ILLUSTRATION	1 APPLICATION	2 DISC PAD		3 ROTOR				4 HI-TENSILE BOLT (NUT) TORQUE		
				Minimum Thickness						
	19.. Make & Model	Pad Set Ref. No.	Minimum Lining Thickness	Machine To	Discard at	Parallelism lack-of	Lat'l runout T.I.R.	Caliper and/or Bracket Mounting	Caliper Bridge or Guide Bolt, Pin, or Key Screw	Wheel Nut Rotor to Hub Nut
	GENERAL MOTORS GROUP CONTINUED									
	CADILLAC—Calais, De Ville, Fleetwood, CC, Brougham, Seville									
J	78-77 Front	728A	.062	.980①	.985②	.0005	.005	—	30	100
	78-77 w/Rear disc	728E	.062	.910	.905	.0005	.003	—	30	100
J	76-72	728A	.062	1.230	1.215	.0005	.005	60U/80L	30-40	105
J	71	728A	.062	1.230	1.215	.0007	.0025	50U/80L	30-40	105
J	70-68	728A	.062	1.230	1.215	.0007	.0025	—	30-40	105
				①for CC cut to 1.230			②discard thickness 1.215			
	El Dorado:									
J	78-77 Front	728A	.062	—	1.170	.0005	.008 hub	—	30	130
	78-77 w/Rear disc	728E	.062	—	1.170	.0005	.008 hub	—	30	130
J	76-69 Front	728A	.062	1.205	1.190	.0005	.008 hub	35	30	105①
	1976 w/Rear disc	728E	.062	1.205	1.190	.0005	.008 hub	—	30	130
D	68	728	.062	1.230	1.215	.0005	.003	90	75-105	105
					①1976—130#'					
	CHEVROLET Full-size—Bel Air, Biscayne, Brookwood, Caprice, Impala, Kingswood, Townsman:									
J	78-77	728A	.020	.980	.965	.0005	.005	—	35	80-100
J	76-71	728A	.030	1.230	1.215	.0005	.005	—	35	70
J	70-68 1-piston	728A	.030	1.230	1.215	.0005	.002	—	35	70
C	68-67 4-piston	762	.030	1.230	1.215	.0005	.004	60-90	130	70
	Intermediates—Camaro 78-70 (ex w/4 w. disc) Chevelle 78-70, Monte Carlo 78 & Down, El Camino 78-70									
J	78-76 ex 78 Malibu & 78 Monte Carlo	728A	.020	.980	.965	.0005	.005	—	35	80
J	78 Malibu & Monte Carlo	7070	.020	.980	.965	.0005	.005	—	35	80
J	75-70	728A	.030	.980	.965	.0005	.005	—	35	70
J	69 Camaro	728A	.030	.980	.965	.0005	.002	—	35	70
	Chevelle	728A	.030	.980	.965	.0005	.002	—	35	70
C	68-67 Camaro	762	.030	.980	.965	.0005	.004	60-90	130	70
C	Chevelle	762	.030	.980	.965	.0005	.004	60-90	130	70
	w 4 whl. disc—Camaro Z28 (69-68), Corvette:									
C	78-76 Front	727	.020	1.230	1.215	.0005	.002F	70	130	80
C	78-76 Rear	727	.020	1.230	1.215	.0005	.003R	70	60	—
C	75-65 Front	727	020	1.130	1.215	.0005	.002	75	130	65
C	Rear	727	.020	1.130	1.215	.0005	.002	75	50	75

5 HYDRAULIC VALVES		6 WHEEL BEARING ADJUSTMENT		
		Step 1	Step 2	Step 3
Metering Front	Proportion Rear	Torque Spindle Nut	Back-off and Retorque	Lock or Back-off and lock Min./Max.
some	yes ex. Limo & CC	12#'	handtight	step 2
no	yes	—	—	—
yes	yes ex.Limo & CC	15#'	handtight	step 2
yes	yes ex. Limo & CC	30#'	6#'	step 2
yes	no	30#'	6#'	step 2
no	yes	none, front drive		
no	yes	—	—	—
yes	yes	none, front drive		
no	yes	—	—	—
yes	yes	none, front drive		
yes	yes	12#'	handtight	½ flat
yes	yes	12#'	skip	1 slot/ 1½ slot
yes	no	12#'	skip	1 slot/ 1½ slot
yes	no	12#'	skip	1 slot/ 1½ slot
yes	yes	12#'	handtight	½ flat
yes	yes	12#'	handtight	½ flat
yes	yes	12#'	skip	1 slot/ 1½ slot
yes	yes	12#'	skip	1 slot/ 1½ slot
yes	no	12#'	skip	1 slot/ 1½ slot
yes	yes	12#'	skip	1 slot/ 1½ slot
yes	no	12#'	skip	1 slot/ 1½ slot
no	yes	12#'	handtight	1 flat
no	yes	—	—	—
no	—	12#'	skip	1 slot/ 1½ slot
—	w/HD	—	—	—

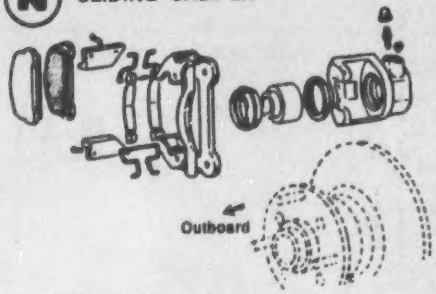
ILLUSTRATIONS

M 2-PISTON FLOATING CALIPER


To 72 Ser. M80,001
Outboard
From 72 Ser. M80,001

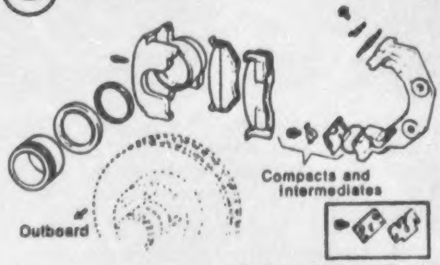
Ford Truck F250 H.D.-350 77-68

N SLIDING CALIPER



English Girling • Japanese •
Toyota Celicá, Corolla, Corona

O SLIDING CALIPER


Compacts and Intermediates
Outboard
Full-size Cars and Trucks

Chrysler Group 78-75, Compacts 77-73, Trucks 77-73

F—Front
R—Rear

T.I.R.—Total Indicator Reading,
T.I.R.—one revolution

U—Upper
L—Lower

S,L—Small, Large
NS—Not Serviceable

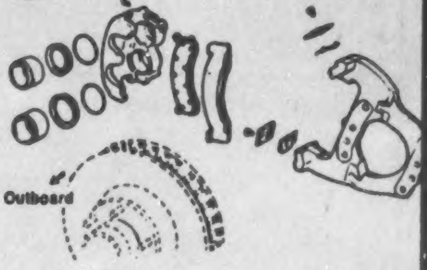
#'—Pound-feet
#"—Pound-inches

ILLUSTRATION	1 APPLICATION	2 DISC PAD		3 ROTOR				4 HI-TENSILE BOLT (NUT) TORQUE		
				Minimum Thickness						
	19.. Make & Model	Pad Set Ref. No.	Minimum Lining Thickness	Machine To	Discard at	Parallelism lack-of	Lat'l runout T.I.R.	Caliper and/or Bracket Mounting	Caliper Bridge or Guide Bolt, Pin, or Key Screw	Wheel Nut Rotor to Hub Nut
	GENERAL MOTORS GROUP CONTINUED									
	Compacts—Chevy II (68-67), Nova:									
J	78-76	728A	.020	.980	.965	.0005	.005	—	35	80
J	75-70	728A	.030	.980	.965	.0005	.005	—	35	70
J	69	728A	.030	.980	.965	.0005	.002	—	35	70
C	68-67	762	.030	.980	.965	.0005	.004	60-90	130	70
	Sub-Compacts—Monza, Vega, Chevette									
K	78-76 Monza	7053	.030	.830	.815	.0005	.005	—	—	89-90
K	77-76 Vega	778	.030	.455	.440	.0005	.005	—	—	80-90
V	78 Chevette	7071	.030	.390	.374	.0005	.003	70	28	70
V	77 Chevette	7055	.030	.456	.441	.0005	.005	70	28	70
V	76 Chevette	7055	.030	.448	.433	.0005	.005	70	28	70
K	75-71	778	.030	.455	.440	.0005	.005	—	—	65
	OLDSMOBILE Full-size—Delmont 88 (68-67), Delta 88, 98, Custom Cruiser:									
J	78-77	728A	.062	.980	.965	.0005	.004	—	35-40	100①
J	76-71	728A	.062	1.230	1.215	.0005	.005	—	40	85-100
J	70-69	728A	.062	1.230	1.215	.0005	.004	—	40	85
C	68-67	762	.062	1.230	1.215	.0005	.004	70	130	80
		①80#' On 77 & 78 Model 88 cars								
	Toronado:									
J	78-76	728A	.062	1.185	1.170	.0005	.004	—	35-40	130
J	75-71	728A	.062	1.205	1.190	.0005	.002	—	40	130
J	70-69	728A	.062	1.205	1.190	.0005	.004	—	40	115
D	68-67	728	.062	1.230	1.215	.0005	.003	54	75-105	80-85,70*
		*Rotor-to-Hub Nut								
	Intermediates—Cutlass/F85, Cutlass Supreme, Vista Cruiser, 4-4-2:									
J	78-76	728A	.062	.980	.965	.0005	.005	125	35-40	80
J	75-71	728A	.062	.980	.965	.0005	.004	—	40	80
J	70-69	728A	.062	.980	.965	.0005	.004	—	40	80
C	68-67	762	.062	.980	.965	.0005	.004	70	130	65
	Compacts—Omega:									
J	78-76	728A	.062	.980	.965	.0005	.005	125	35-40	80
J	75-73	728A	.062	.980	.965	.0005	.004	—	35	70
	Sub-Compacts—Starfire:									
K	78-76	7053	.062	.830	.815	.0005	.005	—	—	80
K	75	778	.062	.455	.440	.0005	.005	—	—	65

5 HYDRAULIC VALVES		6 WHEEL BEARING ADJUSTMENT		
		Step 1	Step 2	Step 3
Metering Front	Proportion Rear	Torque Spindle Nut	Back-off and Retorque	Lock or Back-off and lock Min./Max.
yes	yes	12#'	handtight	1/3 flat
yes	yes	12#'	skip	1 slot/ 1 1/3 slot
yes	no	12#'	skip	1 slot/ 1 1/3 slot
yes	no	12#'	skip	1 slot/ 1 1/3 slot
no	yes	12#'	handtight	1/3 flat
no	no	12#'	handtight	1/3 flat
no	no	12#'	handtight	1/3 flat
no	no	12#'	handtight	1/3 flat
no	no	12#'	handtight	1/3 flat
no	no	12#'	skip	1 nut flat
yes	yes	30#'	handtight	1/3 flat
yes	yes	30#'	handtight	step 2/ 1/24 turn
yes	yes	30#'	handtight	step 2/ 1/24 turn
yes	yes	30#'	handtight	step 2/ 1/24 turn
yes	yes	none, front drive		
yes	yes	none, front drive		
yes	yes	none, front drive		
yes	yes	none, front drive		
yes	yes	30#'	handtight	1/3 flat
yes	yes	30#'	handtight	step 2/ 1/24 turn
yes	no	30#'	handtight	step 2/ 1/24 turn
yes	no	30#'	handtight	step 2/ 1/24 turn
yes	yes	30#'	handtight	1/3 flat
yes	no	30#'	handtight	step 2/ 1/24 turn
yes	yes	30#'.	handtight	1/3 flat
no	no	12#'	skip	1 nut flat

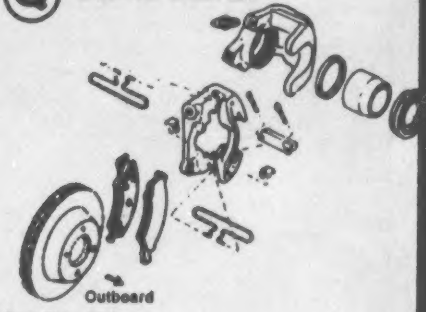
ILLUSTRATIONS

Ⓟ 2-PISTON SLIDING CALIPER



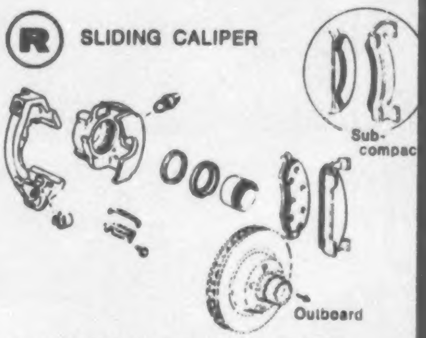
Dodge Motor Homes, Trucks H.D. 77-73

Ⓠ SLIDING CALIPER



Ford Pinto 73-71

Ⓡ SLIDING CALIPER



Amer. Mtrs. 78-74 • Ford Motor Group 78-73
T'bird, Mk. IV. Intermediates 77-72 • IHC 74-71

F—Front
R—Rear

T.I.R.—Total Indicator Reading.
T.I.R.—one revolution

U—Upper
L—Lower

S,L—Small, Large
NS—Not Serviceable

#'—Pound-feet
#"—Pound-inches

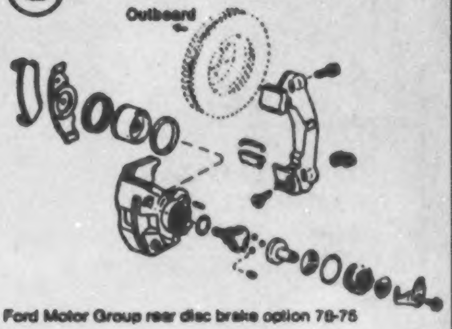
ILLUSTRATION	1 APPLICATION	2 DISC PAD		3 ROTOR				4 HI-TENSILE BOLT (NUT) TORQUE		
	19.. Make & Model	Pad Set Ref. No.	Minimum Lining Thickness	Minimum Thickness Machine To	Minimum Thickness Discard at	Parallelism lack-of	Lat'l runout T.I.R.	Caliper and/or Bracket Mounting	Caliper Bridge or Guide Bolt, Pin, or Key Screw	Wheel Nut Rotor to Hub Nut
	GENERAL MOTORS GROUP CONTINUED **PONTIAC Full-size—Bonneville, Catalina, Executive (73-67), Grand Prix (68-67) Grand Ville:**									
	*Measurement above shoe for riveted lining.									
J	78-77	728A	.020	.980	.965	.0005	.004	—	35	100①
J	76-71	728A	.125*	1.230	1.215	.0007	.005	—	35	75
J	70-69	728A	.125*	1.230	1.215	.0007	.004	—	35	75
C	68-67	762	.020	1.230	1.215	.0005	.004	60	130	75
		①w/4¾ Bolt circLe 80#'								
	Intermediates—Firebird (Inc. Esprit, Formula 400, Trans-Am : **Grand Am, Grand Prix (75-69), GTO (71-67), LeMans, Tempest (71-67), Safari SW:**									
J	78-76 ex below	728A	.020	.980	.965	.0005	.004	—	35	80
J	78 LeMans, Gr Am, G.P.	7070	.020	.980	.965	.0005	.004	—	35	80
J	75-71	728A	.125*	.980	.965	.0007	.004	—	35	70
J	70	728A	.125*	.980	.965	.0007	.004	—	35	70
J	69	728A	.125*	.980	.965	.0007	.004	—	35	70
C	68-67 exc. Grand Prix	762	.020	.980	.965	.0005	.004	60	130	65
C	68-67 Grand Prix: See "Full-size"	◆1970-67 Firebird: proportion valve used with airconditioning option.								
	Compacts—Ventura II, Phoenix									
J	78-76	728A	.020	.980	.965	.0005	.005	—	35	80
J	75-71	728A	.125*	.980	.965	.0005	.004	—	35	70
	Sub-Compacts—Astre, Sunbird									
K	77-76 Astre	778	.030	.820	.815	.0005	.005	—	—	80
K	78-76 Sunbird	7053	.030	.820	.815	.0005	.005	—	30	80
K	75	778	.030	.455	.440	.0005	.005	—	—	65
	CHEV-GMC TRUCKS—El Camino or Sprint, See Chevelle: **1/2 Ton 10/15—Blazer Jimmy, C, G, K, P:** (Note: wheel bearing procedure for 2 WD only)									
J	78-76 Chev	728A	.030	1.230	1.215	.0005	.005	140	35	70-100
J	78-76 GMC	728A	.030	1.230	1.215	.0005	.005	140	35	1/2": 65-90 9/16": 90-120
J	75-71 C 4 x 2, P for. cont.	728A	.030	1.230	1.215	.0005	.005	—	35	65-75
J	75-71 G, van, R.V.	728A	.030	.980	.965	.0005	.005	—	35	70
J	75-71 K 4 x 4	728A	.030	1.230	1.215	.0005	.005	—	35	65
	3/4 Ton 20/25—C, G K, P: **1 Ton 30/35—C, G, P, Exc. Hydro Boost Systems:** (Note: Wheel bearing procedure for 2 WD only)									
J	78-76 Chev.	728A	.030	1.230	1.215	.0005	.005	140	35	90-120
J	78-76 GMC	728A	.030	1.230	1.215	.0005	.005	140	35	1/2": 65-90 9/16": 90-120
J	75-71 C, G, P	728A	.030	1.230	1.215	.0005	.005	—	35	1/2": 65-90 9/16": 90-120
J	75-71 K 4 x 4	728A	.030	1.230	1.215	.0005	.005	—	35	—
	IHC TRUCKS **Scout II, 100/150/200 thru 7500 GVW, Travelall, Travelette (75-74): 1010 (73-72):**									
R	78-76	7056E	.125	1.135	1.120	.0005	.005	115-125	12-18	75-85
R	75-74 exc. FA-7	7056E	.125	1.135	1.120	.0005	.005	110-120	12-16	70-90
I	73-72 1010	781	.125	1.195	1.180	.0005	.004	110-120	30-35	70-90

5 HYDRAULIC VALVES		6 WHEEL BEARING ADJUSTMENT		
		Step 1	Step 2	Step 3
Metering Front	Proportion Rear	Torque Spindle Nut	Back-off and Retorque	Lock or Back-off and lock Min./Max.
yes	yes	12#'	handtight	1/2 flat
yes	yes	12#'	handtight	1/2 flat
yes	no	snug-up	handtight	step 2
yes	no	10-16#'	20-25#'	step 2
yes	yes	12#'	handtight	1/2 flat
yes	yes	12#'	handtight	1/2 flat
yes	yes	snug-up	handtight	step 2
yes	yes ♦	snug-up	handtight	step 2
yes	no ♦	snug-up	handtight	step 2
yes	no ♦	10-16#'	20-25#'	step 2
yes	yes	12#'	handtight	1/2 flat
yes	yes	snug-up	handtight	step 2
no	no	12#'	handtight	1/2flat
yes	yes	12#'	handtight	1/2 flat
no	no	12#'	skip	1 nut flat
yes	yes (some)	12#'	handtight	1/2 flat
yes	yes (some)	12#'	handtight	1/2 flat
yes	yes	15#'	skip	1 nut flat 1/2turn)
yes	yes	15#'	skip	1 nut flat (1/6 turn)
yes	yes	none, front drive		
yes	yes (some)	12#'	handtight	1/2 flat
yes	yes (some)	12#'	skip	1/2 flat
yes	yes	12#'	skip	1 nut flat (1/6 turn)
yes	yes	none, front drive		
yes	yes	30#'	skip	1/4 turn①
yes	yes	to drag	skip	to slot
yes	yes	to drag	skip	to slot

①4 WD only

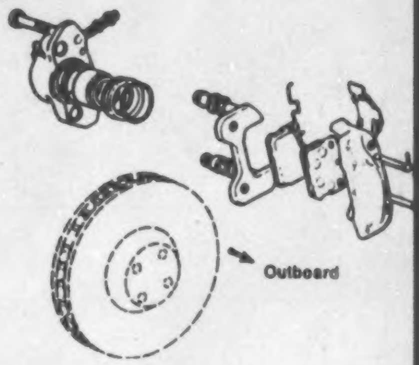
ILLUSTRATIONS

Ⓢ SLIDING CALIPER w/PARKING BRAKE



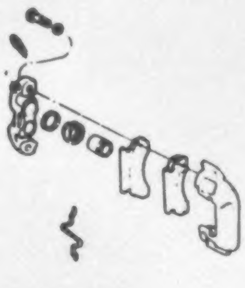
Ford Motor Group rear disc brake option 78-75

Ⓣ FLOATING CALIPER



Dodge Colt 78-74 • Plymouth Arrow 78-76

Ⓤ SLIDING CALIPER



Ford Truck, Dayton Brake 78-76

F—Front
R—Rear

T.I.R.—Total Indicator Reading.
T.I.R.—one revolution

U—Upper
L—Lower

S,L—Small, Large
NS—Not Serviceable

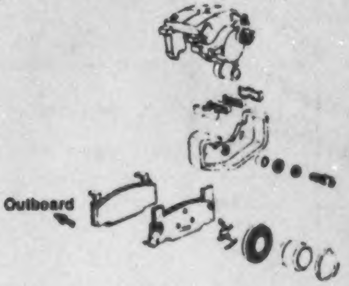
#'—Pound-feet
#"—Pound-inches

ILLUSTRATION	1 APPLICATION	2 DISC PAD		3 ROTOR				[illegible]LE BOLT (NUT) TORQUE		
				Minimum Thickness						
	19.. Make & Model	Pad Set Ref. No.	Minimum Lining Thickness	Machine To	Discard at	Parallelism lack-of	Lat'l runout T.I.R.	Caliper and/or Bracket Mounting	Caliper Bridge or Guide Bolt, Pin, or Key Screw	Wheel Nut Rotor to Hub Nut
	IMPORTED CARS CAPRI (Mercury)									
F	77-78	797	.100	.460	.450	.0004	.002	45-50	—	*30-34
F	74-70	797	.100	—	—	—	.0035	40-50	—	*30-34
					*Disc-to-Hub					
	COLT (Dodge), ARROW (Plymouth)									
T	78-76 ex 78 Wagon	C205	.080	.480	.450	—	.006	29-36	58-69	51-58 (58-72) *25-29
	78 Wagon		.040	.460	.430	—	.006	51-65	—	*25-29
F	75-73	7037	.080							
F	72-71	783	.080	.384	.374	—	.006	30-36	—	*25-29
					*Disc to Hub					
	CHALLENGER/SAPPORO (Dodge/Plymouth)									
Z	78 Front		.040	.460	.430	—	.006	51-65	—	51-58 *25-29
Y	78 Rear		.040	.360	.330	—	.006	29-36	—	(58-72)
	CRICKET (Plymouth)									
F	74-73	7037	.243							
F	72-71	754	.228	.341	.331	.002	.004	—	—	*33
					*Rotor-to-Hub					
	DATSUN									
H	78-76 B210	7039	.063	—	.331	—	.0047	53-72	—	*28-38 58-72
F	73-71 (1200) B110	782	.063	—	.331	.0015	.0012	33-41	—	*20-27
	78-77 810	—	.080	—	.413	—	.0059	53-72	—	*28-38 58-65
H	78-77 200SX	7046	.063	—	.331	—	.0047	53-72	—	*28-38 58-72
H	78-76 F10	7040	.063	—	.339	—	.0059	40-47	—	*18-25 58-65
H	77-75 (8/1/75) 710	7046	.063	—	.331	—	.0047	53-72	—	*28-38 58-65
H	75-73 (up to 8/1/75)710	780	.063	.341	.331	.0028	.0047	53-72	—	*28-38 58-65
	78 510	—	.080	—	.331	.0028	.0047	53-72	—	*28-38 58-65
	72-67 510, 411	780	.040	.341	.331	.0015	.0024	53-65	—	*28-38 58-65
H	77-75 610	7046	.063	—	.331	—	.0047	53-72	—	*28-38 58-65
F	78-76 280Z	794	.079	—	.413	—	.0039	53-72	—	*28-38 58-65
F	75-70 260, 240	794	.030	.423	.413	.0015	.0059	53-71	—	*28-38
					*Disc to Hub nut					

5 HYDRAULIC VALVES		6 WHEEL BEARING ADJUSTMENT		
		Step 1	Step 2	Step 3
Metering Front	Proportion Rear	Torque Spindle Nut	Back-off and Retorque	Lock or Back-off and lock Min./Max.
no	yes	17-25#'	10-15#"	1/2 turn
no	no	27#'	skip	1/4 turn
no	yes	14.5#'	reset at 3.6#'	step 2
no	yes	14.5#'	reset at 3.6#'	step 2
no	no			
no	yes	14.5#'	reset at 3.6#'	step 2
no	yes			
no	no	15-20#'	skip	1/4 turn
no	yes	18-22#'	skip	1/4 -1/8 turn
no	no	22-25#'	skip	1/4 turn
no	yes	18-22#'	skip	1/4-1/8 turn
no	yes	18-22#'	skip	1/4-1/8 turn
no	yes		front drive	
no	yes	18-22#'	skip	1/4-1/8 turn
yes	yes	22-25#'	skip	1/4 turn
no	yes	18-22#'	skip	1/4-1/8 turn
no	yes	22-25#'	skip	1/4 turn
yes(75)	yes	18-22#' (22-25)(75)	skip	1/4-1/8 turn (1/4 turn)
no	yes	18-22#'	skip	1/4-1/8 turn
no	yes	18-22#'	skip	1/4-1/8 turn

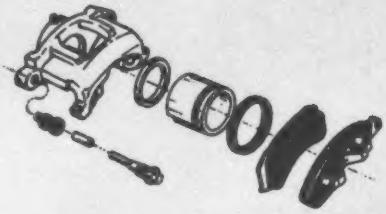
ILLUSTRATIONS

Ⓥ FLOATING CALIPER



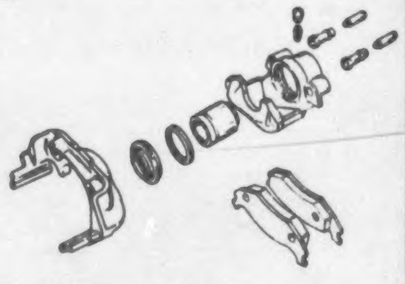
General Motors, Chevette 77-78

Ⓦ SLIDING CALIPER



Fairmont/Zephyr 78

Ⓧ FLOATING CALIPER



Dodge Omni/Plymouth Horizon 78

F—Front
R—Rear

T.I.R.—Total Indicator Reading.
T.I.R.—one revolution

U—Upper
L—Lower

S,L—Small, Large
NS—Not Serviceable

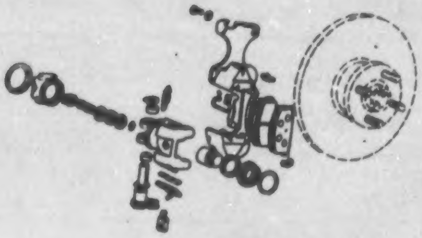
#'—Pound-feet
#"—Pound-inches

ILLUSTRATION	1 APPLICATION	2 DISC PAD		3 ROTOR				4 HI-TENSILE BOLT (NUT) TORQUE		
				Minimum Thickness						
	19.. Make & Model	Pad Set Ref. No.	Minimum Lining Thickness	Machine To	Discard at	Parallelism lack-of	Lat'l runout T.I.R.	Caliper and/or Bracket Mounting	Caliper Bridge or Guide Bolt, Pin, or Key Screw	Wheel Nut Rotor to Hub Nut
	IMPORTED CARS CONTINUED									
	OPEL (Buick)—GT, Kaydette, Manta, 1900:									
G	77-76	783	.067	—	.339	—	.006	36	—	50, *36
G	75	7043	.067							
G	74-71	736	.067	.404	.394	.0006	.004	72	—	65, *36
G	70-68 w1.5, 1.9 eng.	736	.067	.404	.394	.0008	.004	72	—	65, *36
G	w/1.1 eng	736	.067	.404	.394	.0006	.004	50	—	65, *36
					*Disc-to-Hub Nut					
	TOYOTA—Celica, Corolla, Corona, Publica, Hi Lux:									
N	78-76 Celica	7068E*	.040	—	.45①	—	.006	40-54	—	65-86
N	78-76 Corona	7068E*	.040	—	.453	—	.008	50-65	—	65-86
F	76 Corona Mk. II	783	.040	—	.453	—	.006	67-87	—	65-86
F	78-75 Hi Lux Pickup	783	.040	—	.453	—	.0059	67-87	—	65-94
F	75 Corona	783	.040	—	.453	—	.006	50-65	—	65-86
F	78-77 Corolla 1600 except SR 5	7048	.040	—	.35	—	.008	40-54	—	65-86
F	78-77 SR5	7047	.040	—	.35	—	.006	40-54	—	65-86
F	78 Cressida	783	.040	—	.453	—	.006	67-87	—	65-86
N	75-70 Celica, Corolla 1600, Corona	785	When Groove Disappears	.384	.354	—	.006	48	—	70-75
N	74-68 Corolla 1200, 1100; Publica	792		.360	.350	—	.006			
F	74-68 Corona MK. II	783	.040	.384	.374	—	.006	72-87	—	65-86
					*With wear indicator—7068 w/o wear indicator ①1976—.35					
	VOLKSWAGEN—Type 1 Karman Ghia:									
G	74-73	7022	.080							
G	72-67	770	.080	.345	.335	.0006	.008	58-65	NS	108
	Type 2—Transporter Micro-bus, Van, Wagon:									
G	78-76	7021	.078	.472	.453	.0006	.004	123	—	*18 94
G	74-73	7021	.080							
G	72-71	734	.080	.482	.472	.0006	.004	58-87	NS	*14-18 100
					*Rotor-to-Hub Nut					
	Type 3—Fast Back/Square Back									
G	73-65	755	.080	.345	.335	.0006	.006	58-65	NS	108
	Type 4—Sedan 411, 412:									
G	74-73	7023	.080							
G	72-71	796	.080							

5 HYDRAULIC VALVES		6 WHEEL BEARING ADJUSTMENT		
		Step 1	Step 2	Step 3
Metering Front	Proportion Rear	Torque Spindle Nut	Back-off and Retorque	Lock or Back-off and lock Min./Max.
no	no	21#'	skip	1/4 turn
no	no	18#'	skip	1/4 turn/ to slot
no	no	18#'	skip	1/4 turn/ to slot
no	no	18#'	skip	1/4 turn/ to slot
no	yes	21#'	handtight	step 2
no	yes	21#'	handtight	step 2
no	yes	21#'	handtight	step 2
no	yes	22#'	handtight	step 2
no	yes	21#'	handtight	step 2
no	yes	21#'	handtight	step 2
no	yes	21#'	handtight	step 2
no	yes	21#'	handtight	step 2
no	yes	21#'	handtight	step 2
no	yes	19-23#'	handtight	step 2
no	no	snug-up	handtight	end-play .001"/.005"
no	yes	snug-up	handtight	end play .001"/.005"
no	yes	snug-up	handtight	end-play .001"/.005"
no	no	snug-up	handtight	end-play .001"/.005"

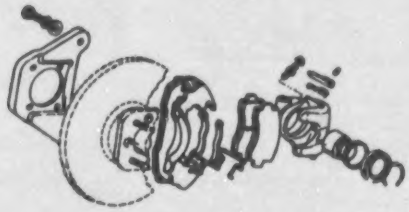
ILLUSTRATIONS

Ⓨ SLIDING CALIPER



Dodge Challenger/Plymouth Sapporo (Rear 78)

Ⓩ SLIDING CALIPER



Dodge Challenger/Plymouth Sapporo (Front 78)

F—Front
R—Rear

T.I.R.– Total Indicator Reading.
T.I.R.—one revolution

U—Upper
L—Lower

S,L—Small, Large
NS—Not Serviceable

#'—Pound-feet
#"—Pound-inches

ILLUSTRATION	1 APPLICATION	2 DISC PAD		3 ROTOR				4 HI-TENSILE BOLT (NUT) TORQUE		
				Minimum Thickness						
	19.. Make & Model	Pad Set Ref. No.	Minimum Lining Thickness	Machine To	Discard at	Parallelism lack-of	Lat'l runout T.I.R.	Caliper and/or Bracket Mounting	Caliper Bridge or Guide Bolt, Pin, or Key Screw	Wheel Nut Rotor to Hub Nut
	IMPORTED CARS CONTINUED **VOLKSWAGEN—Dasher**									
G	78-75	7044	.078	.430	.413	.0008	.004	43	14	65
G	74	7031	.080							
	Rabbit, Scirocco									
G	78-75	7031*	.078	.430	.413	.0008	.004	43	14	65
		*Rabbit Auto. Trans., Scirocco-7044								
	VOLVO 4 Cyl; 140 & 240 SERIES									
E	78-76—Front	—	.062	.557	—	.0012	.004	65-70	—	70-95
F	Girling—Rear	765	.062	.331	—	.0012	.004	38-47	—	70-95
G	ATE—Rear	736	.062	.331	—	.0012	.004	38-47	—	70-95
E	75 Girling—Front	784	.062	.557	—	.0012	.004	65-70	—	70-95
F	75 Girling—Rear	754	.062	.331	—	.0012	.004	38-47	—	70-95
E	ATE—Front	791	.062	.557	—	.0012	.004	65-70	—	70-95
G	ATE—Rear	736	.062	.331	—	.0012	.004	38-47	—	70-95
E	74-67 English Girling brk.:									
E	Frt ex. B20 E eng.	784	.062	.467	.457	.0012	.004	65-70	NS	70-100
	w/B20 E eng	764	.062	.567	.557	.0012	.004	65-70	NS	70-100
F	Rear	765	.062	.341	.331	.0012	.006	45-50	NS	70-100
E	72-71 Ger(ATE) brk, F	791								
G	Ger(ATE) brk, R	736								
	VOLVO 6 Cyl; 260, 160 Series									
E	78-75 260 Front		.062	.900	—	.0012	.004	65-70	—	70-95
	Rear		.062	.331	—	.0012	.004	38-47	—	70-95
E	75-72 164 Front	791								
G	(ATE) Rear	736								
E	72-69 164 Front	784	.062	.467	.457	.0012	.004	65-70	NS	70-100
F	Rear	754	.062	.341	.331	.0012	.006	45-50	NS	70-100
	SPORT COUPE 182, 183, 1800:									
E	73-71 Front	791								
G	73-71 Rear	736								
E	70-68 Front	764	.062	.467	.457	.0012	.004	65-70	NS	70-100
F	70-69 Rear	754	.062	.341	.331	.0012	.006	45-50	NS	70-100

5 HYDRAULIC VALVES		6 WHEEL BEARING ADJUSTMENT		
		Step 1	Step 2	Step 3
Metering Front	Proportion Rear	Torque Spindle Nut	Back-off and Retorque	Lock or Back-off and lock Min./Max.
no	yes	none, front drive		
no	yes	none, front drive		
no	yes	50#'	skip	1/3 turn/ to slot
no	yes	50#'	skip	1/3 turn/ to slot
no	yes	50#'	skip	1/3 turn/ to slot
no	yes	50#'	skip	1/3 turn/ to slot
no	yes	50#'	skip	1/3 turn/ to slot
no	yes	50#'	skip	1/3 turn/ to slot
no	yes	50#'	skip	1/3turn/ to slot
no	—	50#'	skip	1/3 turn/ to slot
no	—	50#'	skip	1/3 turn/ to slot
—	yes			
no	—	50#'	skip	1/3 turn/ to slot
—	yes	—	—	—
no	—	50#'	skip	1/3 turn/ to slot
—	yes			
no	—	50#'	skip	1/3 turn/ to slot
—	yes			

Brake - Disc Brake System and Service

No. D-5 Disc Brake Application Chart

Information Sheet # 2

Disc Brake Application Chart

Vehicle Manufacturer	Year	Fixed Four Piston Caliper	Floating or Sliding Caliper Single Piston
AMERICAN MOTORS			
Some	1978-73		Bendix
Some	1978-71		Kelsey Hayes
All	1970-65	Bendix	
CHRYSLER CORPORATION			
Imperial	1975-73		Kelsey Hayes
Full Size Models	1978-73		Kelsey Hayes
Intermediates	1978-73		Kelsey Hayes
Challenger, Barracuda	1974-73		Kelsey Hayes
Dart, Valiant	1978-73		Kelsey Hayes
Dodge Omni, Plymouth Horizon	1978		Kelsey Hayes
Imperial	1972-70		Kelsey Hayes
Full Size Models	1972-69		Kelsey Hayes
Intermediates, Challenger, Barracuda	1972-70		Kelsey Hayes
Valiant, Dart	1972-65	Kelsey Hayes	
Barracuda	1969-65	Kelsey Hayes	
Imperial	1969-68	Budd	
Full Size Models	1968	Budd	
Intermediates	1969-68	Bendix	
FORD MOTOR COMPANY			
Lincoln	1972-70		Kelsey Hayes
Full Size Models	1972-68 (1)		Kelsey Hayes
All but Full Size Models	1972-68 (1)		Kelsey Hayes
Mustang	1967-65	Kelsey Hayes	
Lincoln	1969-65	Kelsey Hayes	
Pinto	1973-71		Bendix
Thunderbird, Mark IV, Montego, Torino	1972		Bendix
All Models exc. below	1978-73		Kelsey Hayes
Maverick, Mustang	1978-74		Bendix
GENERAL MOTORS			
Buick Full Size	1978-70		Delco Moraine
Buick Special	1978-69		Delco Moraine
Buick Full Size	1969-67	Bendix	
Buick Special	1968-67	Delco Moraine	
Buick Skyhawk	1978-76		Delco Moraine
Buick Skyhawk	1975		Delco Moraine
Cadillac Eldorado	1978-69		Delco Moraine
Cadillac	1978-68		Delco Moraine
Cadillac Eldorado	1968-67	Kelsey Hayes	
Chevrolet Full Size	1978-69		Delco Moraine
Corvette	1978-65	Delco Moraine	
Camaro, Chevelle, Nova	1978-69		Delco Moraine
Chevrolet Full Size	1968-67	Delco Moraine	
Chevy II, Chevelle, Camaro	1968-67	Delco Moraine	
Vega	1977-71		Delco Moraine
Monza	1978-76		Delco Moraine
Monza	1975		Delco Moraine
Oldsmobile Toronado	1978-69		Delco Moraine
Oldsmobile 88 & 98	1978-69		Delco Moraine
Oldsmobile F85, Cutlass	1978-69		Delco Moraine
Oldsmobile Toronado	1968-67	Kelsey Hayes	
Oldsmobile 88 & 98	1968-67	Delco Moraine	
Oldsmobile F85	1968-67	Delco Moraine	
Oldsmobile Starfire	1978-76		Delco Moraine
Oldsmobile Starfire	1975		Delco Moraine
Pontiac Full Size	1978-69		Delco Moraine
Pontiac, Phoenix	1978		Delco Moraine
Tempest, Le Mans, Firebird, G.P.	1978-69		Delco Moraine
Ventura	1978-71		Delco Moraine
Sunbird	1978-76		Delco Moraine
Sunbird	1975		Delco Moraine
Astre	1977-75		Delco Moraine
Pontiac Full Size	1968-67	Delco Moraine	
Tempest, Le Mans, Firebird	1968-67	Delco Moraine	

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(1) Except 1972 Montego, Thunderbird, Torino and Mark IV

MASTER CYLINDERS
VALVES
POWER BOOST
ANTI-SKID

REFERENCE

The texts chosen were selected because they are in current use by the instructors who compiled this manual. You should have a copy of at least one in your shop.

The text books are to be used as references for each exercise in this book. For each exercise you will find a number followed by page numbers. Look up the book number on this list and the page numbers will correspond to the exercise on which you are working. For example, if you find #4. 103-111 in the reference section, you would check this reference list and find that book No. 4 is Auto Mechanics by H. E. Ellinger. In that book, pages 103-111 will apply to the exercise you are working.

	TEXT	AUTHOR	PUBLISHER
1.	Auto Service and Repair 1975	Stockel	Goodheart - Willcox
2.	Auto Mechanics Fundamentals 1974	Stockel	Goodheart - Willcox
3.	Automotive Encyclopedia 1975	Toboldt - Johnson	Goodheart - Willcox
4.	Auto Mechanics 1977 Second Edition	Ellinger	Prentice - Hall
5.	Automotive Mechanics 1970 Sixth Edition	Crouse	McGraw - Hill
6.	The Auto Book 1974	Crouse	McGraw - Hill

Auto Mechanic
Brakes
No. E-Index

E-1 Safety

E-2 Master Cylinder

E-3 Brake Valves and Switches

E-4 Power Boosters

E-5 Anti-Skid Systems

Auto Mechanics
Brakes - Master Cylinder, Power Boost, Control Valves
No. E- 1 Safety

OBJECTIVE: After completion of this unit you will be able to safely work on master cylinder, power boost, control valves meeting all safety standards.

EXPLANATION: Some of the brake components and materials are hazardous to the mechanic and the vehicle finish. The completed brake service must be within specifications or the vehicle will be a safety hazard and the mechanic may be liable.

MATERIALS NEEDED: Safety glasses

TOOLS NEEDED:

References	Do
#1. pp. 29-3 to 29-8	#1. Read references
#2. pp. 340-344	
#3. --	
#4. pp.421-424, 450-452	
#5. pp. 525 and 526	
#6. p. 574	
#7.	
#8.	

Auto Mechanics
Brakes - Master Cylinders, Power Boost, Control Valves
No. E-2

OBJECTIVE: After completion of this exercise you will be able to identify all the components of a master cylinder, explain its operation and service the unit.

EXPLANATION: Knowing the names of the parts and the operation of the master cylinder will help you in servicing it.

MATERIALS NEEDED: Safety glasses,brake fluid, denatured alcohol, brake kleen, lint free rags.

TOOLS NEEDED: Hand tools, brake hone, bleeder hoses and fittings for bench bleeding, ¼" wide .006 feeler gauge, drill.

References	Do
#1. pp. 29-1 to 29-8	#1. Study reference assignments
#2. pp. 340-344, 350	#2. Complete written worksheets
#3. pp. 512-516, 536	#3. Check with instructor
#4. pp. 421p424, 437-438, 450-452	
#5. pp. 509-511	
#6. pp. 570-574	
#7.	
#8.	

No. E-2 Master Cylinder

Information Sheet # 1

INTRODUCTION

The master cylinder is a type of hydraulic pump that is operated by a push rod attached to the brake pedal or by a hydraulic push rod that is part of a power brake. The cylinder provides a means of converting mechanical force into hydraulic pressure.

Two general types of master cylinders are in use on American made passenger cars and light trucks . .
. . Dual System Master Cylinders, and
. . Single System Master Cylinders

SINGLE SYSTEM MASTER CYLINDER:

The master cylinder body is made of cast iron. The top of the casting is a reservoir that stores extra brake fluid that may be needed by the system. The reservoir also provides an area into which the fluid can expand when its temperature rises. The lower part of the body contains the cylinder, which is a long, smooth hole in which a piston can slide back and forth. Two holes, or ports, connect the reservoir to the cylinder. (Fig. 1).

The Inlet Port: The filler port is a large hole connecting the reservoir with the cylinder. It allows fluid to flow from the reservoir into the cylinder.

The Compensating Port: The compensating port is a small hole connecting the reservoir to the cylinder. This hole allows for the expansion and contraction of the brake fluid caused by changes in temperature. The heat produced by braking causes the fluid to expand, and this expansion creates an excess of fluid in the system. When the brake pedal is released, the compensating port is uncovered, and the excess fluid escapes to the reservoir. When the temperature of the fluid in the system drops, the fluid can return to the system.

The Piston: The piston used in the master cylinder is spool-shaped and is fitted with two cups or seals. It is pushed forward in the cylinder when the brake pedal is depressed. Then the force of the piston applies pressure to the fluid in the system.

The Primary Cup: The forward cup, or seal, on the piston is called the primary cup. It seals in all the pressure ahead of the piston.

The Secondary Cup: The secondary cup provides a sealed chamber behind the primary cup. Fluid flows from the reservoir, through the filler port, and into this chamber. Since the sealing edges of both the primary and secondary cups face forward, the fluid in this chamber can flow under the edges of the primary cup and into the cylinder. However, the fluid cannot flow past the secondary cup; and, as a result, it cannot leak out of the cylinder.

The Residual Pressure Valve (Check Valve): The residual pressure valve is found in master cylinders used in drum brake systems. This valve maintains a slight static pressure in the hydraulic system at all times, even when the brake pedal is released. The pressure varies from 5 psi to 20 psi, depending on the particular system. This slight pressure holds the lips of the wheel-cylinder piston cups tightly against their cylinder walls. Thus it aids in keeping air from entering the system when the system is at rest.

The Push Rod: The push rod transmits to the master cylinder piston the force that the driver applies to the brake pedal. As the piston must return completely to uncover the compensating port after each brake application, the length of the push rod is very critical. The push rod must be adjusted so that there is a slight bit of free play, or travel, between the rod and the piston when the brake pedal is released.

DUAL SYSTEM MASTER CYLINDER:

A dual master cylinder is a combination of two single master cylinders in a single casting body. The pistons share the same cylinder, but each system is actuated independently. This situation provides two separate systems, and leakage or failure in one system will not impair the operation of the other system. Common practice is to operate the front brakes with one section and the rear brakes with the other. Fig. 2 shows a sectioned view of a typical dual master cylinder and labels the parts.

Dual master cylinders are used with drum brake, disc brake, and combination systems, the section that serves the disc brakes does not have a residual pressure check valves in their outlet ports. When used with disc brakes or combination systems, the section that serves the disc brakes does not have a residual pressure check valve; a disc brake system must have no residual pressure.

Residual pressure in a disc brake system would hold the shoes in contact with the rotor. This contact would cause dragging brakes, overheating, and unnecessary wear.

Reservoir Cover and Seal: The reservoir cover is vented to the atmosphere but is fitted with a diaphragm-type seal. This seal acts as a gasket to prevent leakage. It also serves to separate the surface of the fluid from the atmosphere. As brake fluid is hydroscopic, this seal helps prevent contamination of the fluid with water absorbed from the air.

Dual System Tandem Cylinder Fail-Safe Feature: Should the primary sectinn of the dual system suffer a pressure loss, a stop projecting from the primary piston bottoms against the secondary piston and actuates it mechanically; a loss of secondary pressure, on the other hand, forces the secondary piston stop to bottom against the end of the cylinder before the primary piston can finish displacing fluid and build higher braking pressure. Thus a pressure failure causes one part of the system to use one half of the pedal travel in order to "bottom out" and suddenly the customary pedal stroke more than doubles in order to develop the remaining braking action. This safety reserve is small because the piston stops block the pedal at a point above the floor board and, because the reservoirs must be divided, the usable fluid reserve for each brake is limited. Police and other special vehicles equipped with manual brake adjusters must be kept in close adjustment continually; privately owned vehicles require automatic brake adjustment. Otherwise substantial increases in lining clearances, due to wear, could cancel the safety feature by requiring a fluid displacement large enough to "run out" the pedal stroke before the remaining brakes could apply.

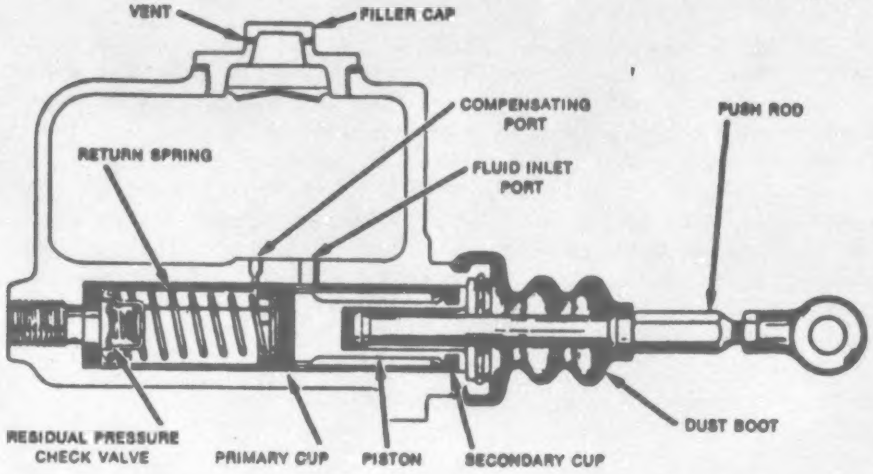

VENT
FILLER CAP
COMPENSATING PORT
PUSH ROD
RETURN SPRING
FLUID INLET PORT
DUST BOOT
RESIDUAL PRESSURE CHECK VALVE
PRIMARY CUP
PISTON
SECONDARY CUP

FIGURE 1 Single System Master Cylinder

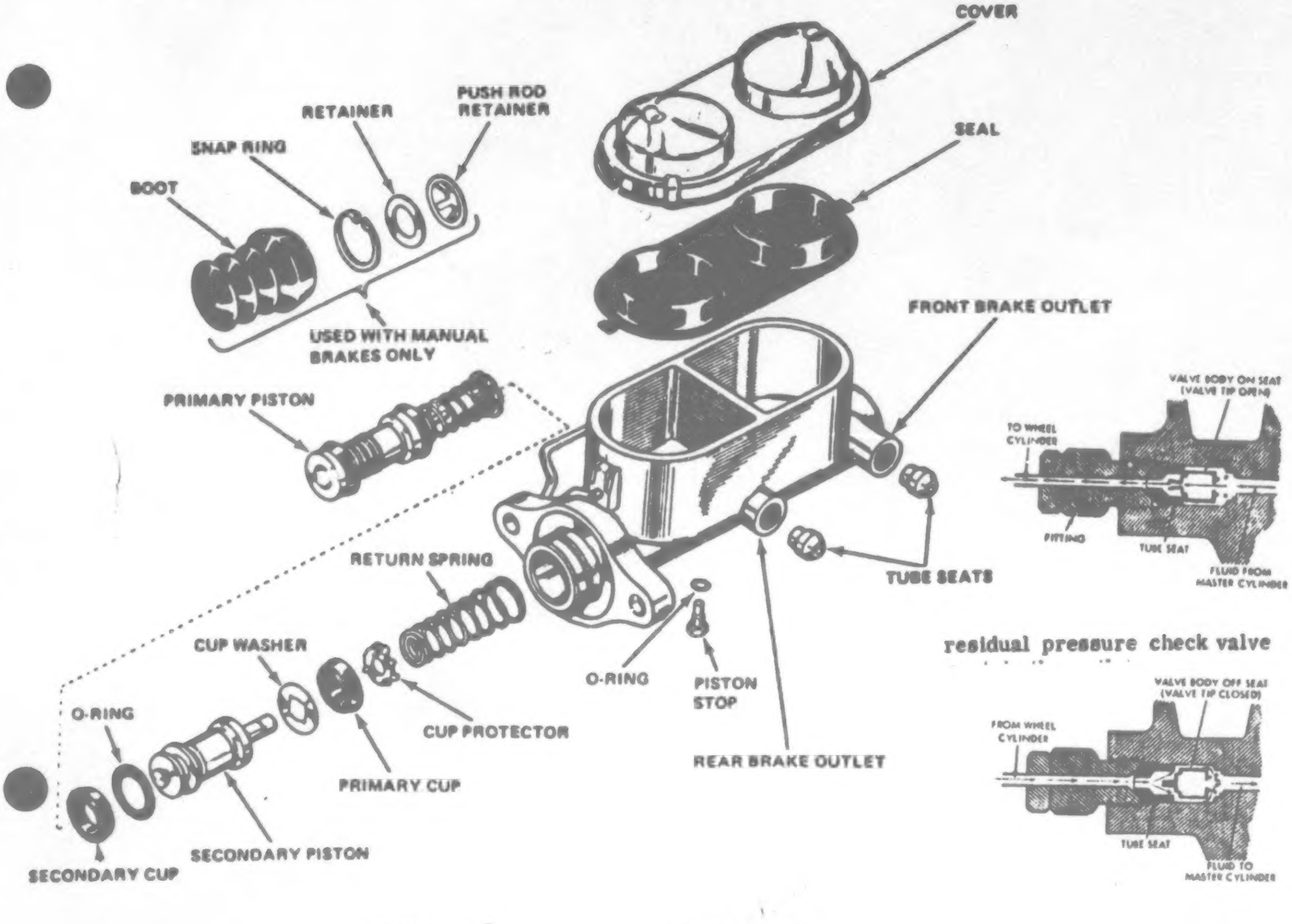
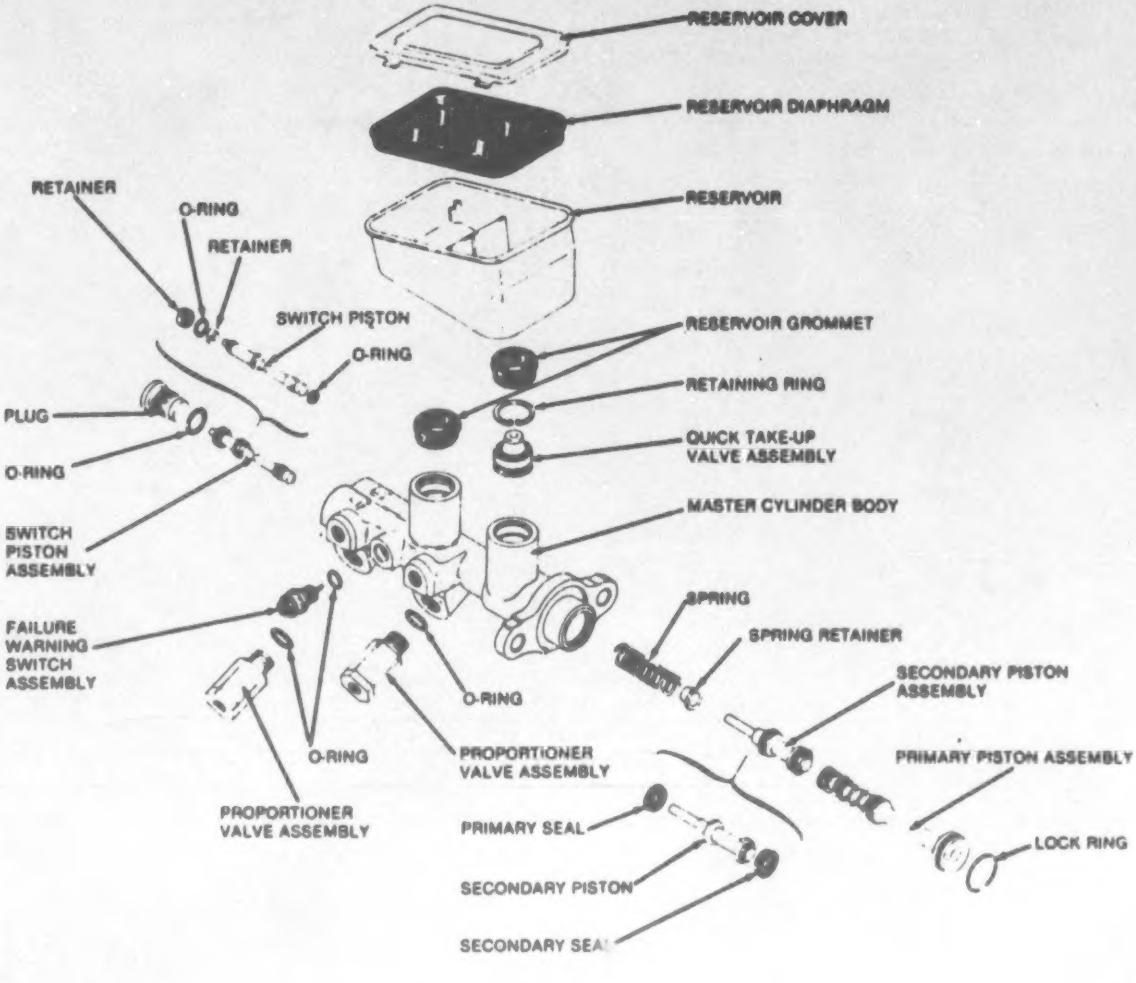

COVER
PUSH ROD RETAINER
RETAINER
SNAP RING
BOOT
SEAL
USED WITH MANUAL BRAKES ONLY
FRONT BRAKE OUTLET
PRIMARY PISTON
VALVE BODY ON SEAT (VALVE TIP OPEN)
TO WHEEL CYLINDER
FITTING
TUBE SEAT
FLUID FROM MASTER CYLINDER
TUBE SEATS
RETURN SPRING
residual pressure check valve
CUP WASHER
O-RING
PISTON STOP
VALVE BODY OFF SEAT (VALVE TIP CLOSED)
FROM WHEEL CYLINDER
O-RING
CUP PROTECTOR
REAR BRAKE OUTLET
PRIMARY CUP
SECONDARY PISTON
SECONDARY CUP
TUBE SEAT
FLUID TO MASTER CYLINDER

FIGURE 2 Master Cylinder

MASTER CYLINDER ASSEMBLY - G.M.

Gernal Description

This master cylinder is designed for use in a diagonal split system (one front and one rear brake served by the primary piston, and the opposite front and rear brakes served by the secondary piston). It incorporates the functions of the standard dual master cylinder plus a warning light switch and proportioners. In addition, a quick take-up feature is incorporated, which provides a large volume of fluid to the wheel brakes at low pressure with initial brake application. The low pressure fluid quickly provides the displacement requirements created by the seal retracting pistons into the front calipers and spring retraction of the rear drum brake shoes.

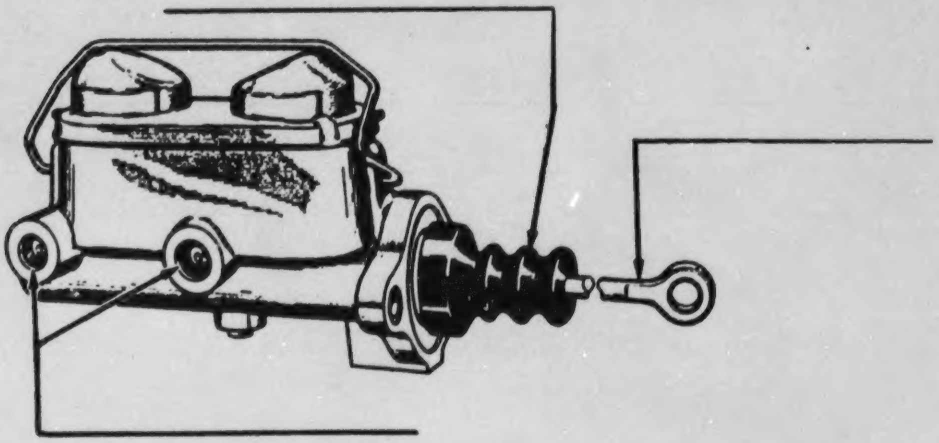

RESERVOIR COVER
RESERVOIR DIAPHRAGM
RETAINER
O-RING
RETAINER
RESERVOIR
SWITCH PISTON
O-RING
RESERVOIR GROMMET
RETAINING RING
PLUG
QUICK TAKE-UP VALVE ASSEMBLY
O-RING
MASTER CYLINDER BODY
SWITCH PISTON ASSEMBLY
SPRING
SPRING RETAINER
FAILURE WARNING SWITCH ASSEMBLY
SECONDARY PISTON ASSEMBLY
O-RING
O-RING
PROPORTIONER VALVE ASSEMBLY
PRIMARY PISTON ASSEMBLY
PROPORTIONER VALVE ASSEMBLY
PRIMARY SEAL
LOCK RING
SECONDARY PISTON
SECONDARY SEA

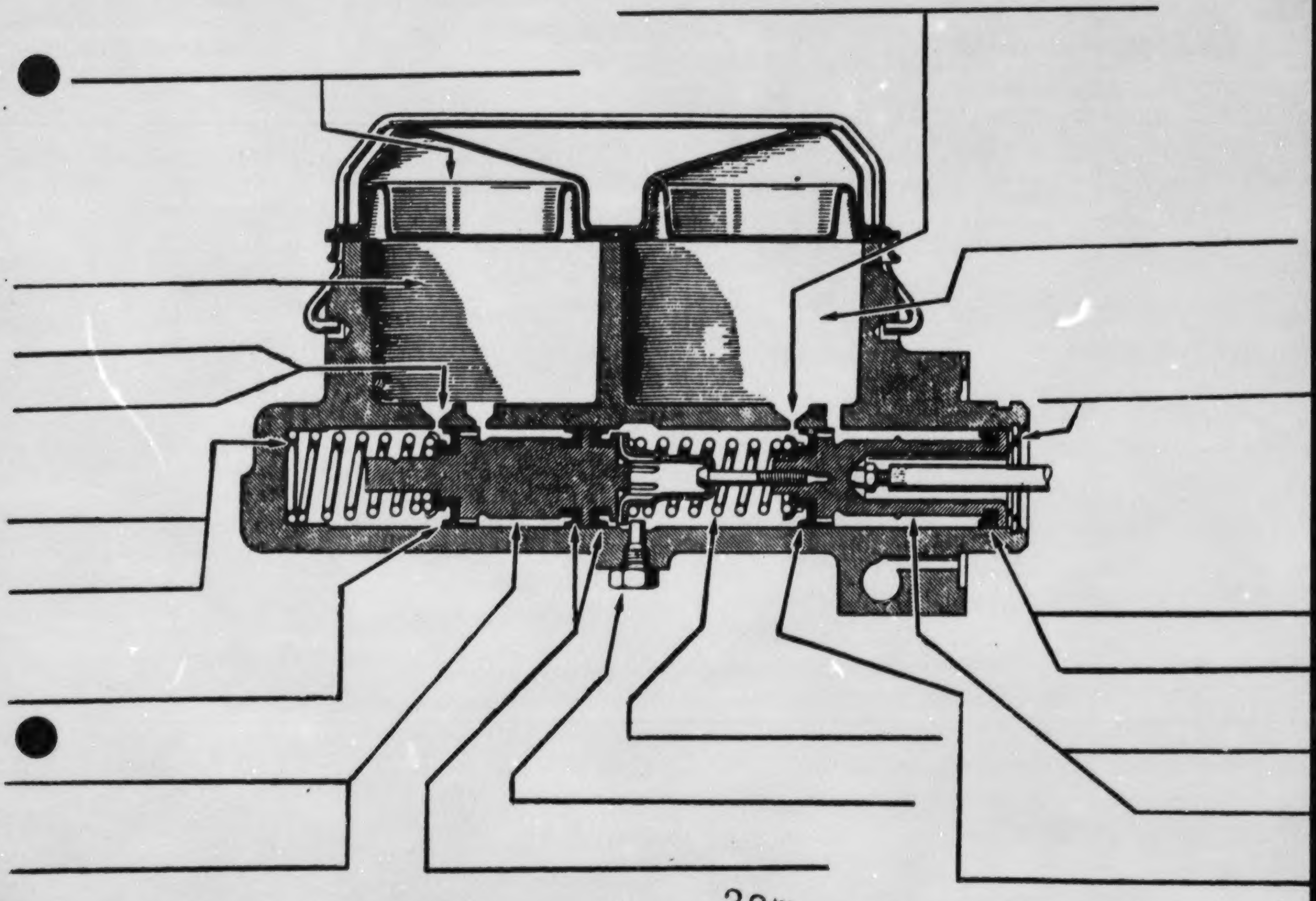
Brakes-Master Cylinder, Power Boost, Control Valves
No. E-2

Worksheet #1

Name____Date____________Grade________

Instructor's Initials _____





Brakes - Master Cylinder, Power Boost, Control Valve

No. E-.2 Master Cylinder

Worksheet # 2

Name________________________ **Date**______________ **Grade**________

1. Examine master cylinder for external leaks:____________________

2. Test and Diagnose master cylinder for internal leaks.______________

3. Check reservoir levels.______________________________

4. General condition of master cylinder. (Note: External or internal leakage along with high milage or age of vehicle many indicate replacement rather than rebuild.)______________________________________

5. Remove master cylinder; see service manuals for directions on disconnecting linkage on cars with manual brakes. Cars with power brakes do not require linkage removal. Reservoir servicing disc brake system should be drained before removing master cylinder.

6. Disassemble master cylinder, note position of parts. Bore to piston clearance?______________

   Rebuild or Replace?________________

   If rebuild continue with worksheet.

7. Clean master cylinder, hone cylinder bore, clean master cylinder again. Make sure intlet and compensating parts are open, used compressed air. Recheck piston to bore clearance.____________________________

8. Reassemble master cylinder using brake or assembly fluid. Be careful not to damage seals when installing piston assemblies or piston stop pin.________________

9. Bench bleed master cylinder.____________

10. Replace master cylinder on vehicle and check for proper compensating port clearance; see information sheet #2, page 2 "Bleeding and Checking." Also see service manuals for individual vehicle specifications and directions for linkage adjustments, manual and power brakes.

11. Test vehicle for firm pedal, no slow decrease in pedal height, no decrease in fluid level.________________

MASTER CYLINDER SERVICING

Just like any other brake parts, master cylinders require periodic service. The usual reason for a master cylinder failure is that the seals don't seal any more. Fluid leaks past seals internally, and sometimes shows up as an external leak as well. The rubber parts wear with usage or may deteriorate with age or fluid contamination. Corrosion or deposits formed in the bore due to moisture or dirt in the hydraulic system may result in wear of the cylinder bore or the parts therein.

A step-by-step service procedure for a typical master cylinder is described below.

REMOVAL AND DISASSEMBLY - (Refer to Worksheet # 1)

a). Clean the area around the master cylinder to prevent dirt and grease from contaminating the cylinder or the hydraulic lines. Disconnect the tubes, remove nuts or bolts that secure the master cylinder to firewall or power brake, and remove the master cylinder from the car.
On cars with manual brakes, the push rod must be disconnected from the brake pedal before removing the master cylinder from the car.

b). Remove the reservoir cover, and drain the brake fluid from the reservoir. Then remove the piston stop bolt, if present, from the master cylinder. Slide the primary piston assembly out of the master cylinder. Next, remove the secondary piston assembly by tapping the master cylinder, or by using needle nose pliers to pull it from its bore, or by carefully using compressed air. Disassemble the piston assemblies.

c). Clamp the master cylinder in a vise with outlet ports facing up. Test for presence of check valve by probing with wire through hole in tube seats. Replace tube seat(s) and check valve(s) only if check valve is present and supplied in rebuild kit. Remove the tube seat inserts, if required, by partially threading a self-tapping screw into each tube seat and using two screwdrivers, as shown in Fig. 1, to pry each seat out of the master cylinder. Remove the residual check valve and the spring from the outlet(s) (if present).

CLEANING AND INSPECTION

Thoroughly clean the master cylinder and any other parts to be reused in clean alcohol. DO NOT USE PETROLEUM PRODUCTS FOR CLEANING. If the bore is not badly scored, rusted or corroded, it is possible to rebuild the master cylinder. A slight bit of honing is permissible to clean up and smooth out the bore. A master cylinder rebuilding kit and fresh fluid should be used. If the cylinder bore is badly pitted or corroded, or if it has been rebuilt before, the master cylinder should be replaced with a new or rebuilt one. Crocus cloth or an approved cylinder hone should be used to remove lightly pitted, scored, or corroded areas from the bore. Brake fluid can be used as a lubricant while honing lightly. After using the crocus cloth or a hone, the master cylinder should be thoroughly washed in

CLEANING AND INSPECTION- Cont'd.

clean alcohol or brake fluid to remove all dust and grit. If alcohol is used, dry parts thoroughly before reinstalling. CAUTION: Other solvents should not be used. Then the clearance between the bore wall and the piston (primary piston of a dual system master cylinder) should be checked. If a narrow (1/8" (3.2mm) to 1/4" (6.4mm) wide 0.006" (o.15mm) feeler gauge can be inserted between the wall and a new piston, the clearance is excessive, and the master cylinder should be replaced. Be sure to note the relative positions of all the parts, paying particular attention to the way the rubber cups are facing. Lubricate all new rubber parts with brake fluid or brake system assembly lubricant.

REASSEMBLY AND INSTALLATION - (Refer to Worksheet # 1)

a). Carefully install the new cups or seals in the same positions and in reverse order of the old ones.
b). Placing the small end of the pressure spring into the secondary piston retainer, slide the assembly into the cylinder bore, taking care not to nick or gouge any rubber part.
c). Place the primary piston assembly over the secondary piston shoulder and push both assemblies into the bore.
d). Use the lubricant very generously to keep from damaging the seals.
e). Install and tighten the piston retaining screw and gasket, while holding the pistons in their seated positions. At the same time, reinstall any piston snap rings.
f). Install the residual check valve and spring in the small master cylinder outlet (or both outlets, if originally present). If the tube seat inserts were removed, install new seats in both fluid outlets making sure that they are securely seated.

BLEEDING AND CHECKING

a). Bleed the hydraulic system. (Bench bleed master cylinder).
b). Check master cylinder compensating port clearance by watching for a spurt of brake fluid in front reservoir when brake pedal is slightly depressed, indicating proper port clearance.

BENCH BLEEDING PROCEDURE

Bench bleeding the tandem master cylinders saves time and money. In order to expel all air that might have been trapped in the cylinder, tandem master cylinders should be bench bled before they are installed on the vehicle. Bench bleeding reduces the possibility of air getting in the brake lines. Follow this simple procedure for bench bleeding:

a). Route two shortened brake lines from the outlet connection(s) into the fluid reservoir(s), below the normal fluid level (Fig.2).
b). Fill the reservoir(s) with fresh brake fluid and pump the cylinder until air bubbles no longer appear in the reservoir. If the cylinder does not have a check valve at the outlet port, close off the tubing during the back stroke. Otherwise, the fluid will merely pump back and forth in the tubing.

BENCH BLEEDING PROCEDURE Con'd.

c). When all air has been purged from the master cylinder, install the master cylinder on the vehicle, taking care not to spill fluid. Remove bleeding tubes and connect brake lines. Catch the fluid in a rag to avoid damaging car finish.

d). Manually bleed at brake line connection to master cylinder to remove any small amount of air trapped when connecting lines.

e). Refill reservoirs and install cap. Brake fluid should be added to maintain the fluid level 1/4" to 1/2" (6 to 13mm) from the top of the reservoir.

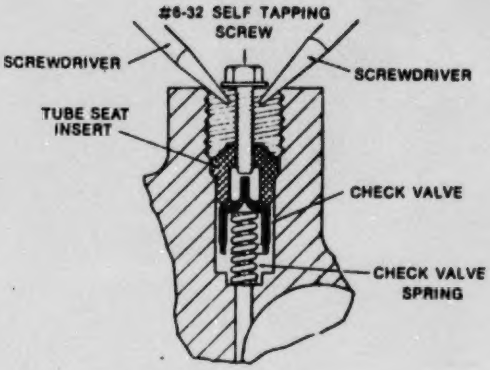

#6-32 SELF TAPPING SCREW
SCREWDRIVER
SCREWDRIVER
TUBE SEAT INSERT
CHECK VALVE
CHECK VALVE SPRING

FIGURE 1 Removing Inserts from the Master Cylinder Ports

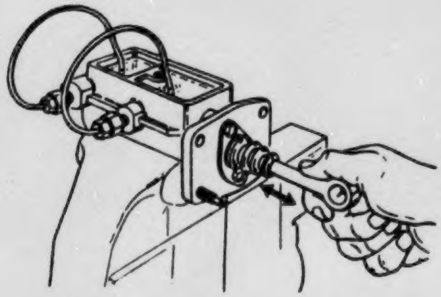


FIGURE 2 Bench Bleeding Tandem Master Cylinder

Brakes - Master Cylinder, Power Boost, Control Valves

No. E-2 Master Cylinder

Test

Name________________________________ **Date**____________ **Grade**___________

True or False

_______ 1. The compensating port is larger than the inlet port.

_______ 2. The primary cup is the forward cup or seal on the piston.

_______ 3. Residual pressure valve (Check valve) maintains a pressure of 30-40 psi to keep air from entering the system when it is at rest.

_______ 4. The reservoir and cylinder servicing the front disc brakes will have a residual pressure valve in the master cylinder outlet.

_______ 5. Failure of one half of a dual master cylinder will result in increased brake pedal travel to apply brakes.

_______ 6. Piston stop pins need not be removed when removing and installing both pistons in a dual master cylinder.

_______ 7. Tube seats are pressed into the outlets of a dual master cylinder and cannot be removed.

_______ 8. 10 W oil may be used as an assembly fluid on the rubber piston cups and seals.

_______ 9. The clearance between piston and master cylinder bore should not exceed .015 inch.

_______10. The clearance between piston and master cylinder bore should be checked with a 1/8 or 1/4 inch wide feeler gauge.

_______11. While bench bleeding a master cylinder the bleed line(s) should extend well below the fluid level in the reservoir.

_______12. It is necessary to always bleed the wheel cylinders whenever just the master cylinder has been rebuilt or replaced.

_______13. Two mechanics are discussing master cylinders.
Mechanic A says that disc brakes require larger reservoirs than do drum brakes.

Mechanic B says that disc brakes require residual pressure (check) valves.

Who is right?
A. A only
B. B only
C. Both A and B
D. Neither A nor B

_________14. Tube seats are usually used in

A. filler ports
B. outlet ports
C. bleeder ports
D. compensating ports

_________15. A car owner states that brake fluid is leaking from behind the brake pedal and dripping on the carpet. The most probable cause of this problem is a defective

A. primary cup on the primary piston
B. secondary cup on the primary piston
C. primary cup on the secondary piston
D. secondary cup on the secondary piston

_________16. Most master cylinders have a diaphragm seal under the cover of the reservoir. This seal is used to

A. maintain pressure in the system
B. prevent fluid evaporation
C. prevent the entrance of moisture-laden air
D. prevent fluid leakage past the primary cup

_________17. Brakes that drag or fail to release can be caused by a

A. leaking primary cup
B. plugged compensating port
C. failure of the residual pressure valve (check valve)
D. leaking secondary cup

_________18. A master cylinder push rod must be adjusted so that

I. there is a slight bit of free play present before the push rod moves the piston
II. the compensating port is uncovered by the primary cup

A. I only
B. II only
C. Both I and II
D. Neither I nor II

_________19. A drum brake system requires frequent bleeding to maintain a firm pedal. The most probable cause of this problem is a

A. restricted compensating port
B. leaking primary cup
C. leaking residual pressure valve (check valve)
D. leaking diaphragm seal

No. E-2 Master Cylinder

Test

20. Explain the procedure for checking and adjusting the push rod to piston clearance on a car equipped with power brakes and a dual master cylinder.

Auto Mechanics
Master Cylinder, Power Boost, Control Valves

No. E-3 Valves

OBJECTIVE: Upon completion of this unit the student will understand the function and location of brake system valves.

EXPLANATION:

MATERIALS NEEDED: Safety glasses

TOOLS NEEDED:

References		Do	
#1.	pp. 29-29 to 29-30	#1.	Read text
#2.	pp. 344-355	#2.	Read information sheets
#3.	--	#3.	Complete worksheets
#4.	p. 424	#4.	Check with instructor
#5.	p. 514	#5.	Take tests
#6.	pp. 583-584		
#7.			
#8.			

VALVES

Most hydraulic brake systems are fitted with automatic valves. One type of valve turns on a warning light to notify the driver of a system failure. Another type ensures balance in braking between the front and rear wheels. Still another valve delays the application of the front brakes until a certain pressure is built up in the system

These valves are found as individual units on some cars and are combined in a single assembly on others. The types of valves used on any car are determined by the manufacturer. They are chosen to provide the best braking action for the particular brake system used on the car. Proper diagnosis of braking problems requires that you understand the function of these valves and the problems caused by their failure.

Pressure Differential Valves All autos equipped with a dual master cylinder have a warning light on the instrument panel. That light notifies the driver if one of the dual braking systems fails. The light is turned on by a switch incorporated into a pressure differential valve similar to the one shown in Fig. 1.

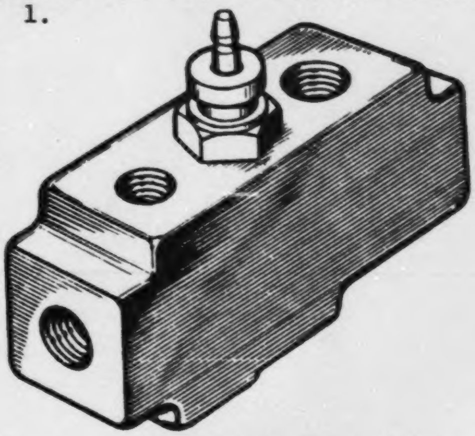


Figure 1 A pressure differential valve (courtesy Chevrolet Service Manual, Chevrolet Motor Division).

The pressure differential valve is connected to the two brake lines that connect the master cylinder with the other parts of the two braking systems. It detects differences in pressure between the two systems.

c

The pressures in dual braking systems are equal when the systems are functioning properly and, therefore, a difference in pressure indicates an abnormal condition. The most common type of pressure differential valve consists of a spool-shaped piston floating in a passage that connects both systems. As long as the pressure in both systems is equal, the piston will remain in the center of the passage (Fig. 2). But if the pressure in one system drops, the higher pressure in the other system moves the piston off center (Fig. 3).

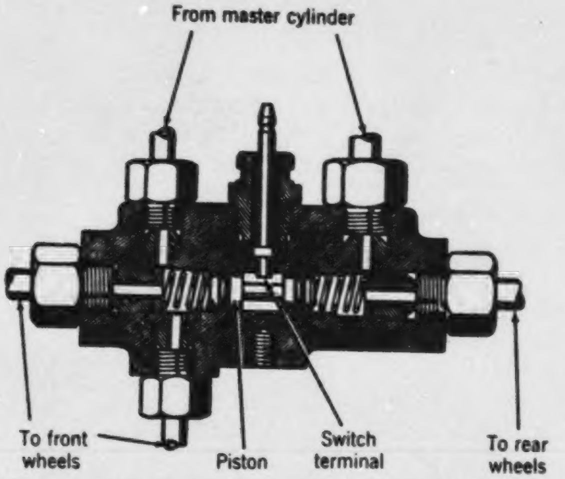


Figure 2 A pressure differential valve with the piston in the centered position (courtesy Chevrolet Service Manual, Chevrolet Motor Division).

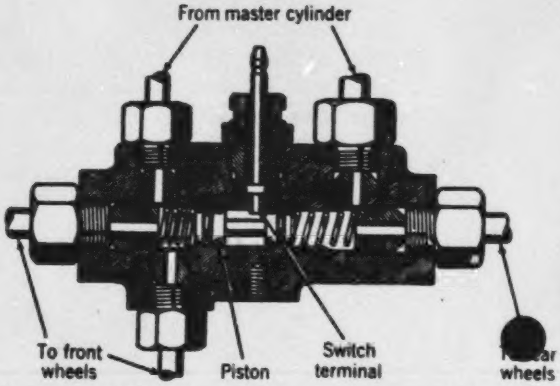


Figure 3 A Pressure differential valve with the piston in an off-center position. The position of the valve indicates a failure in the front brake system (courtesy Chevrolet Service Manual, Chevrolet Motor Division).

When the piston is moved off center, one of its inner edges comes into contact with the switch terminal. This contact completes the ground circuit for the warning light, and the light goes on.

There are pressure differential valves of different designs, but basically there are only two types--(1) the self-centering type and (2) the noncentering type.

The self-centering type uses springs on both sides of the piston to recenter the piston when the brake pedal is released. With this type of valve the warning light operates only while the brake pedal is depressed. When the brake pedal is released, the light goes out. The valve shown in Fig. 2 is of the self-centering type.

The noncentering type of pressure differential valve does not use springs. When the piston is moved to either side, it does not return when the brake pedal is released. With this type of valve, the warning light remains on until the system has been repaired and the switch has been hydraulically recentered.

In most instances, normal brake bleeding procedures cause the piston in either type of valve to shift, causing the light to go on. If the valve is of the self-centering type, it returns to the center position when the bleeding operations have been completed. Noncentering valves usually become recentered after a few hard brake applications. If you encounter a valve that will not center itself, you may be able to move it in the following manner:

1. Check to see that there are no leaks in the system, that the system is free of air, and that the master cylinder reservoirs are full.

2. Loosen one of the lines or open one bleeder valve.
3. Slowly press down on the brake pedal.
4. If the light goes out, slowly release the pedal and tighten the loose fitting or valve. If the light does not go out, tighten the fitting or valve you have loosened, and loosen one in the other system.
5. Slowly press down on the brake pedal again. The light-should go out. Tighten the loose fitting or valve.

Pressure differential valves are not adjustable and parts are not available for their repair. When a pressure differential valve is defective, you must replace it.

Proportioning Valves

Proportioning valves are used to improve the balance of braking between the front and rear wheels. Stops from high speeds using high system pressures can cause the rear wheels to lock and skid. This problem is due to the weight shift to the front wheels that takes place during braking. Cars equipped with combination brake systems are especially prone to rear wheel locking because the drum brakes used on the rear are self-energizing whereas the disc brakes used on the front are not.

Many cars use a proportioning valve in the rear brake system to eliminate this tendency to skid. The valve reduces the pressure applied to the rear wheel cylinder in relation to the pressure applied to the front calipers. The actual amount of pressure reduction depends on the amount needed for each type of car, and it is determined by the manufacturer. Proportioning valves may be in separate units as shown in Fig. 4, or they may be incorporated into a combination valve.

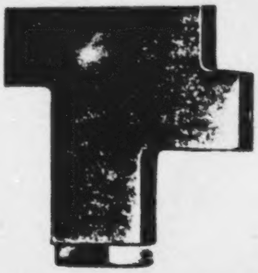


Figure 4 A proportioning valve (Chrysler Corporation).

A defective proportioning valve is indicated when the rear wheels tend to lock during sudden stops. Proportioning valve operation can be tested only by using gauges as recommended in the manufacturer's service manual. Two high-pressure gauges are needed for the test. One gauge is connected to the line from the rear brake section of the master cylinder by means of a T-fitting. The second is connected to the outlet port of the proportioning valve.

When the brake pedal is depressed, the first gauge indicates the output pressure of the master cylinder, and the second indicates the reduced pressure. Fig. 5 shows two gauges being used to test a proportioning valve. Proportioning valves are neither adjustable nor repairable. When defective they must be replaced.

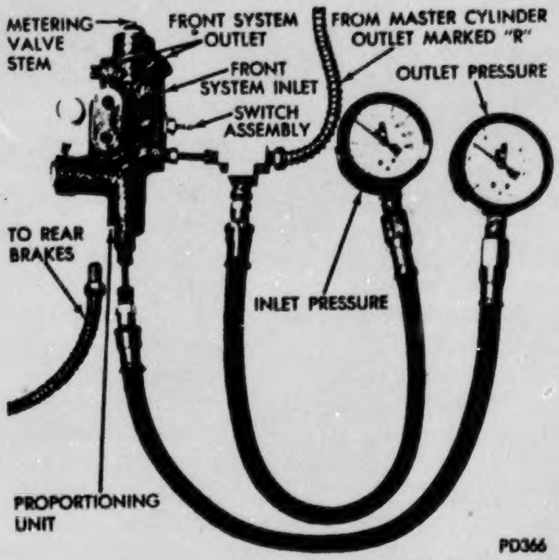

METERING VALVE STEM
FRONT SYSTEM OUTLET
FROM MASTER CYLINDER OUTLET MARKED "R"
FRONT SYSTEM INLET
OUTLET PRESSURE
SWITCH ASSEMBLY
TO REAR BRAKES
INLET PRESSURE
PROPORTIONING UNIT
PD366

Figure 5 Testing a proportioning valve. Note that the outlet pressure is lower than the inlet pressure (Chrysler Corporation).

Metering Valves

Metering valves are used on many cars with combination brake systems. These valves delay the flow of brake fluid to the front calipers until the pressure in the system rises to a certain point. The delay permits the system pressure (1) to overcome the tension of the rear brake-shoe retracting springs, (2) to expand the shoes, and (3) to apply the rear brakes before the front brakes are applied. Metering valves are used to prevent the front brakes from locking during light braking on icy or slippery roads.

Metering valves are sparate from other valves on some cars. On most cars, however, they are combined with another valve in a common housing (Fig. 6).

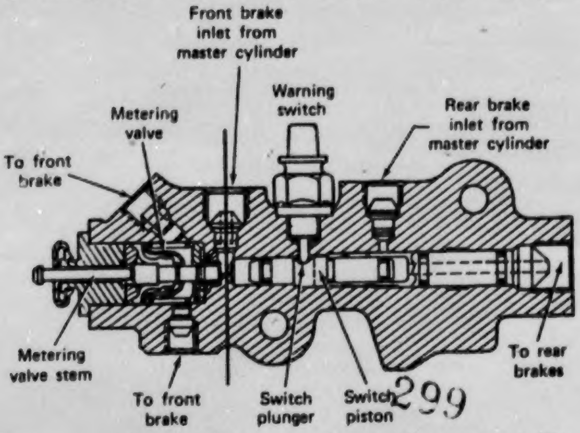

Front brake inlet from master cylinder
Warning switch
Metering valve
Rear brake inlet from master cylinder
To front brake
Metering valve stem
To rear brakes
To front brake
Switch plunger
Switch piston

Figure 6 A metering valve combined with a pressure differential valve (courtesy American Motors Corporation).

Metering valves are designed to remain open when there is no pressure in the brake system. This operation allows the fluid in the system to expand and contract with temperature changes. As soon as the brakes are applied, the valve closes (usually in the 3 to 5 psi range), and pressure is applied only to the rear brake system. As braking pressure increases, the valve opens (usually in the 30 to 140 psi range), and the front brake system is pressurized. Since the metering valve functions only in a relatively low pressure range, it has no effect on braking during stops from high speeds.

A metering valve will close under the pressure required for bleeding operations. Therefore, when you bleed a system that incorporates a metering valve, you must hold the valve open. All metering valves have an external stem or button to use for holding the valve open.

Stem Type

To hold open metering valves that have an exposed stem, such as the valve in Fig. 6, pull the stem outward. You can pull it with your fingers, but the simple tool shown in Fig. 7 makes the job easier. When you have to bleed a system that has a stem type of metering valve, compress the tool between your fingers and place it over the stem. When the tool is released, its spring action pulls the stem outward, holding the valve open

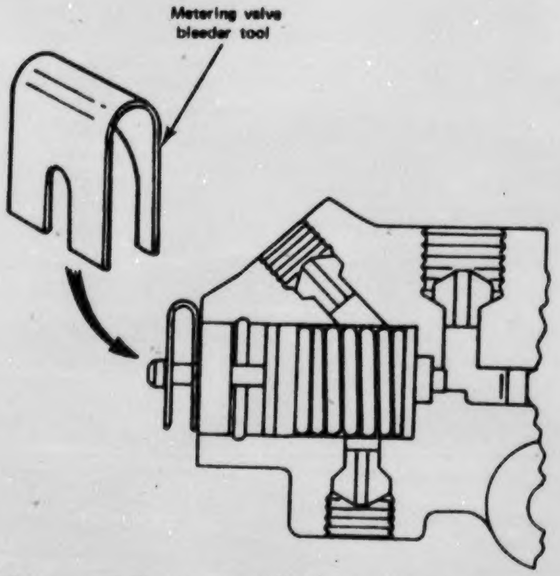


Figure 7 Stem-type metering valve held open by a tool (Ford Motor Company).

Button Type

The button type of metering valve has an exposed button. As shown in Fig. 8, the button is actually a rubber boot that covers the valve stem. To hold this type of valve open, you can push the button inward as shown in Fig. 9. You can also hold the button type of valve open with a simple tool (Fig 10). The slotted end of this tool is slipped under one of the valve mounting bolts. If you hold the button in and tighten the bolt, the valve will remain open for bleeding operations.

Whenever you use a tool a hold a metering valve open while you bleed brakes, do not forget to remove the tool after you have completed the bleeding operations.

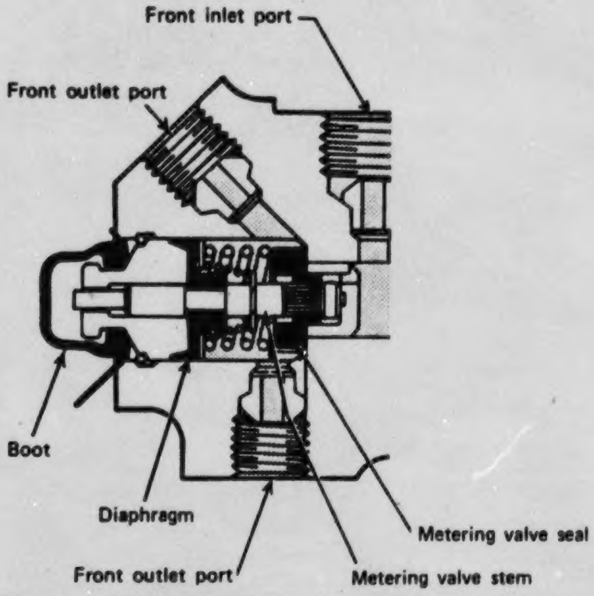

Front inlet port
Front outlet port
Boot
Diaphragm
Metering valve seal
Front outlet port
Metering valve stem

Figure 8 Sectional view of a metering valve. Note the boot covering the valve stem (courtesy Chevrolet Service Manual, Chevrolet Motor Division).

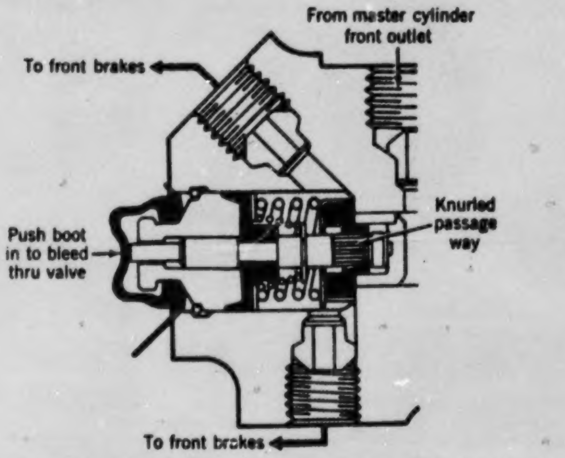

From master cylinder front outlet
To front brakes
Knurled passage way
Push boot in to bleed thru valve
To front brakes

Figure 9 Sectional view of a metering valve held in the open position (courtesy Chevrolet Service Manual, Chevrolet Motor Division).

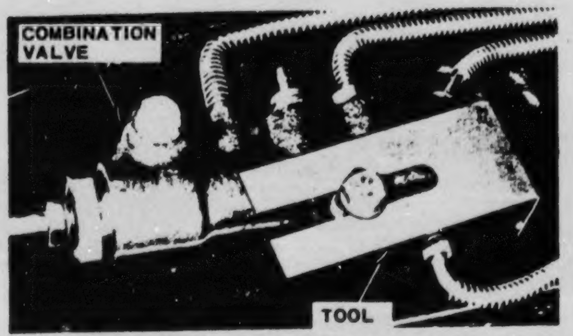

COMBINATION VALVE
TOOL

Figure 10 A metering valve bleeder tool holding the valve open (courtesy American Motors Corporation).

Metering valves can be checked by two methods:

1. Depress the brake pedal slowly. Usually you can feel a slight bump after the pedal moves about one inch. The bump indicates that the valve is functioning.
2. Have someone depress the brake pedal slowly while you watch or feel the stem or button. The movement of the stem or button, which can usually be seen or felt, indicates that the valve is functioning.

Faulty metering valves cannot be adjusted or repaired. If a faulty metering valve is combined with another valve or valves in a common housing, the entire assembly must be replaced.

Comination Valves

A combination valve is, as its name implies, the combining of all of the valves in a particular system. Such a valve can contain a pressure differential valve, a proportioning valve, and a metering valve (Fig. 11). Combination valves are usually mounted on the frame, the firewall, or a side panel near the master cylinder. The position of such valves, their appearance, and their service procedure varies, even among cars made by the same manufacturer.

Faulty combination valves must be replaced as a unit, even if only one of the combined valves is defective.

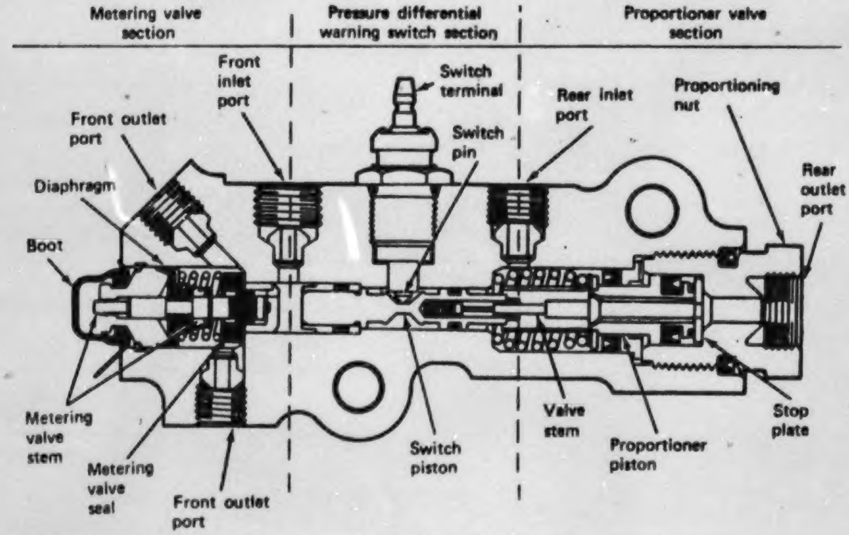

Metering valve section
Pressure differential warning switch section
Proportioner valve section
Front inlet port
Switch terminal
Rear inlet port
Proportioning nut
Front outlet port
Switch pin
Diaphragm
Rear outlet port
Boot
Metering valve stem
Metering valve seal
Front outlet port
Switch piston
Valve stem
Proportioner piston
Stop plate

Figure 11 A three-function combination valve (courtesy American Motors Corporation).

Brakes - Master Cylinder, Power Boost, Control Valves

No. E-3 Valves

Worksheet # 1

Name ______________________________ Date ____________ Grade __________

REMOVAL AND INSTALLATION OF HYDRAULIC SYSTEM VALVES

The types and locations of hydraulic system valves vary with each make or model of car. For this reason proper removal and installation procedures can be found only in the manufacturers' manuals. Certain precautions, however, must be taken in replacing any hydraulic system valves. Those precautions are listed below.

Removal Precautions

1. Always use tubing wrenches when you remove the lines from the valves.
2. Always support the valve with an open-end wrench when you loosen the fittings. (Pliers are needed in some instances.)
3. If the valve is supported at the frame or body, precaution number 2 may not be necessary, but loosen all fittings before you loosen the supporting bolts or clamps.
4. Take care not to bend the tubing when you disengage the flared ends. This precaution minimizes alignment problems during installation.

Installation Precautions

1. Position all lines and start all threads by hand. Do not use a wrench on any fitting until you are sure the threads are properly aligned and started. Do not tighten any fitting until all the fittings have been started.
2. After all fittings are hand-threaded in place, install any attaching bolts or clamps.
3. Use a tubing wrench to tighten all lines, supporting the valve if necessary.
4. Thoroughly clean the valve, and the lines near the valve to ensure the detection of leaks.
5. Bleed the system in the sequence specified by the manufacturer.
6. Check for leaks.

Instructor's Initials ________

Brakes - Master Cylinder, Power Boost, Control Valves

No. E-3 Valves

Test #1

Name____Date______________Grade_______

IDENTIFY VALVE FUNCTION AND LOCATION

Satisfactory Performance
A satisfactory performance on this job requires that you do the following:

1. Place the number of each valve listed below in front of the items below the list that best relate to that valve. Not all the statements relate to the valves listed.
2. Place the correct valve number in front of 8 items within 10 minutes.

Performance Situation
1. Pressure differential valves
2. Proportioning valves
3. Metering valves

__________ delay the application of pressure to the front brakes.

__________ may be located in the line to the rear brakes.

__________ operate only at low pressures.

__________ are a part of both the front and rear systems.

__________ maintain a residual pressure in the system.

__________ operate switches to turn on warning lights.

__________ decrease the pressure applied to the rear brakes.

__________ must be considered when bleeding the front calipers.

__________ operate only at high pressures.

__________ may be located in the line to the front brakes.

Brakes - Master Cylinder, Power Boost, Control Valves

No. E-3 Valves

Test # 2

Name____ Date______________ Grade______

SELF-TEST

Each incomplete statement or question in this test is followed by four suggested completions or answers. In each case select the one that best completes the statement or answers the question.

1. A proportioning valve is used
   I. on cars with combination brake systems
   II. to reduce the hydraulic pressure at the rear brakes.
   A. I only
   B. II only
   C. both I and II
   D. Neither I nor II

2. The application of hydraulic pressure to the front calipers on some cars is delayed by a
   A. metering valve
   B. proportioning valve
   C. residual pressure valve
   D. pressure differential valve

3. A car owner states that the front wheels of a car lock up on icy roads, even when braking with light pedal pressure. The most probable cause of this problem is a defective
   A. metering valve
   B. proportioning valve
   C. residual pressure valve
   D. pressure differential valve

4. A car owner states that the rear wheels lock and slide when attempting to bring the car to a fast stop from high speeds. The most problem cause of this problem is a defective
   A. metering valve
   B. proportioning valve
   C. residual valve
   D. pressure differential valve

Auto Mechanics
Master Cylinder, Power Boost, Control Valves
No. E-4 Power Boost

OBJECTIVE: Upon completion of this unit you will be able to understand operation, and repair of power assist units.

EXPLANATION:

MATERIALS NEEDED: Safety glasses

TOOLS NEEDED:

References	Do
#1. pp. 29-9 to 29-10	#1. Read the assigned references
#2. pp. 356-360	#2. Read information sheets
#3. pp. 526-530	#3. Complete worksheets
#4. pp. 430-434	#4. Check with your instructor
#5. pp. 516-519	
#6. pp. 587-591	
#7.	
#8.	

Brakes - Master Cylinder, Power Boost, Control Valves

No. E-4 Power Boost

Information Sheet # 1

Power Assist Unit

Power assist unit greatly multiply the force applied to the brake pedal. Most power assist units are vacuum brake boosters. They use engine intake manifold vacuum and atmospheric pressure to multiply the driver's effort. Some power assist units are hydraulic boosters. In those units the pressure for the brake booster is provided by the hydraulic pump that also provides pressure for the power steering.

Vacuum Brake Boosters

Most vacuum brake boosters now in use are called vacuum suspended units. The term vacuum suspended describes the condition of the unit when the car engine is running and the brakes are released. When in that condition, vacuum is present on both sides of a diaphragm so that the diagphragm is suspended in a vacuum. Fig. 1 shows a cross-sectional view of a typical vacuum suspended brake booster.

Though all the booster components are combined in a single unit, or assembly, a vacuum suspended booster consists of two subassemblies. Those subassemblies are the power chamber and the control valve.

The Power Chamber: The power chamber applies the force to the master cylinder piston. The chamber consists of a front shell, a rear shell, a supported diaphragm, a diaphragm return spring, and a push rod. These parts are shown in Fig. 2.

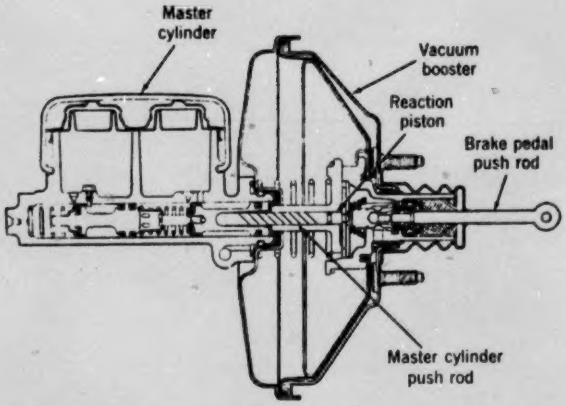

Master
cylinder
Vacuum
booster
Reaction
piston
Brake pedal
push rod
Master cylinder
push rod

Figure .1 A vacuum suspended booster unit (courtesy American Motors Corporation).

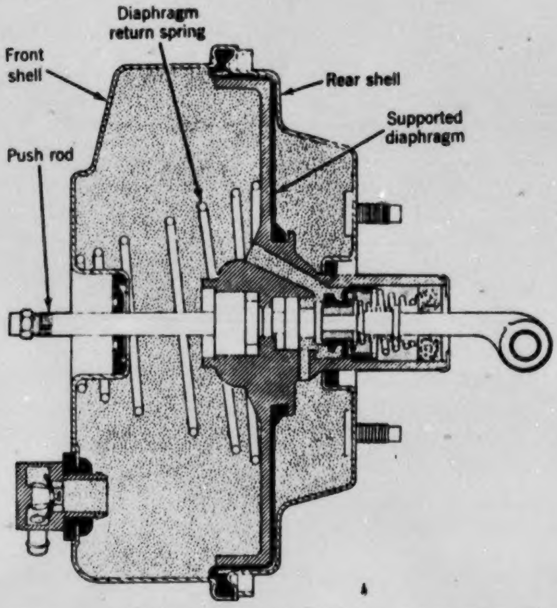

Diaphragm
return spring
Front
shell
Rear shell
Supported
diaphragm
Push rod

Figure .2 Major components of the power chamber (Ford Motor Company).

The Control Valve: The control valve determines the amount of force the power chamber applies to the master cylinder piston. It does this by opening and closing two ports: (1) the vacuum port and (2) the atmospheric port. The control valve is a spool-type valve built into the hub of the diaphragm. It is actuated by the driver through a rod attached to the brake pedal (Fig. 3).

Operation of Vacuum Suspended Booster
All vacuum suspended boosters function in three modes, or positions. This positions are (1) released, (2) applied, and (3) holding.

Released Position Fig. 4 shows the position of the booster parts when the unit is in the released position. When the brake pedal is released, engine intake manifold vacuum evacuates the air from the front shell of the power chamber through the check valve. Since the valve rod is in the rear position, the valve plunger is also held to the rear. This holds the vacuum port open, allowing vacuum to evacuate the air from the rear shell. Because manifold vacuum is present on both sides of the diaphragm, the pressure on both sides of it are equal. This allows the diaphragm spring to hold the diaphragm to the rear. Then the pushrod exerts no force on the master cylinder piston.

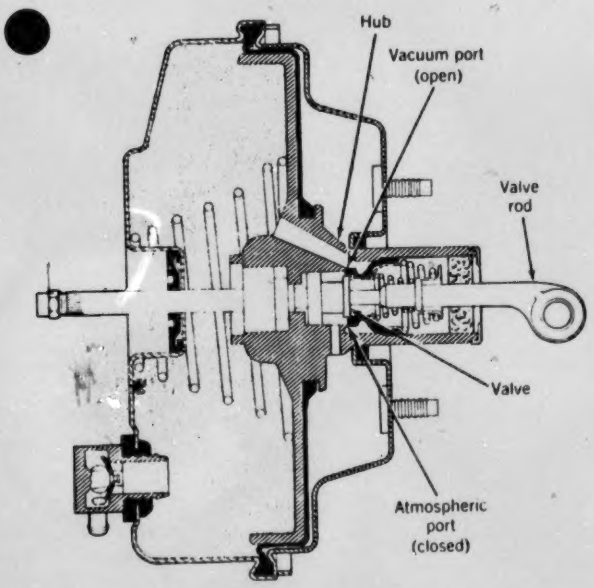

Hub
Vacuum port (open)
Valve rod
Valve
Atmospheric port (closed)

Figure .3 Major components of the control valve (Ford Motor Company).

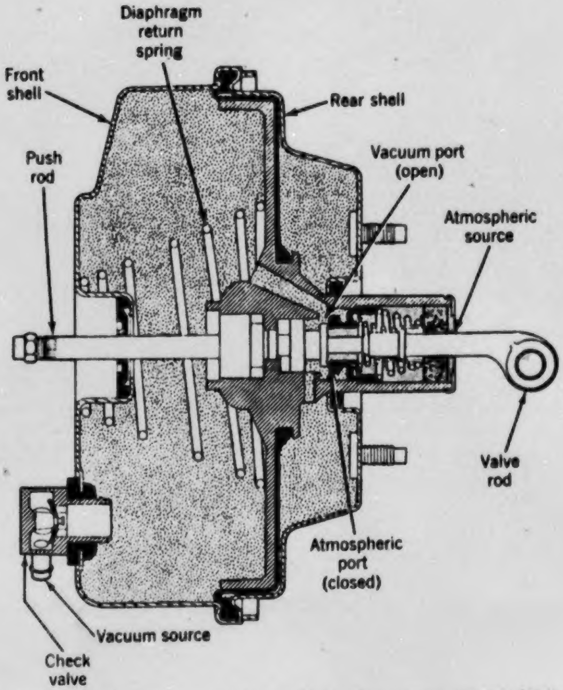

Diaphragm return spring
Front shell
Rear shell
Push rod
Vacuum port (open)
Atmospheric source
Valve rod
Atmospheric port (closed)
Vacuum source
Check valve

Figure .4 Booster in the released position (Ford Motor Company).

Applied Position When the driver depresses the brake pedal, the valve rod pushes the valve plunger forward. This closes the vacuum port and opens the atmospheric port, as shown in Fig. 5. Atmospheric pressure enters the rear shell of the power chamber through the air filter near the valve rod. Since manifold vacuum is maintained in front of the diaphragm, the air pressure behind the diaphragm pushes the diaphragm forward. The movement of the diaphragm is transmitted by the pushrod to the master cylinder piston.

Holding Position Most driving conditions require only gradual braking. To provide such braking, a position between the released and applied position must be provided. This is why the control valve is mounted in the hub of the diaphragm. When the diaphragm moves forward, the valve body moves away from its control rod. The valve body closes the atmospheric port as shown in Fig. 6. This valve action regulates the pressures on the diaphragm, giving the driver control over the degree of braking. Additional pedal movement reopens the atmospheric port and causes the pushrod to exert more force on the master cylinder piston.

Reducting the pressure on the brake pedal closes the atmospheric port. This causes a pressure drop on the rear of the diaphragm and decreases the force applied to the master cylinder piston. If the pedal is held in one position, the movement of the diaphragm centers the valve, closing both the vacuum port and the atmospheric port. This maintains a continuous holding force on the pushrod.

Since the vacuum suspended booster unit requires only that a valve be moved to apply or release the brakes, the driver would experience no "feel" when pressing on the brake pedal unless there were some special provision for it. The absence of feel would make it very difficult to bring a car to smooth, controlled stop, To provide feel,a reaction device is built into the booster. This may consist of a rubber disc or an assembly of spring steel levers. It is

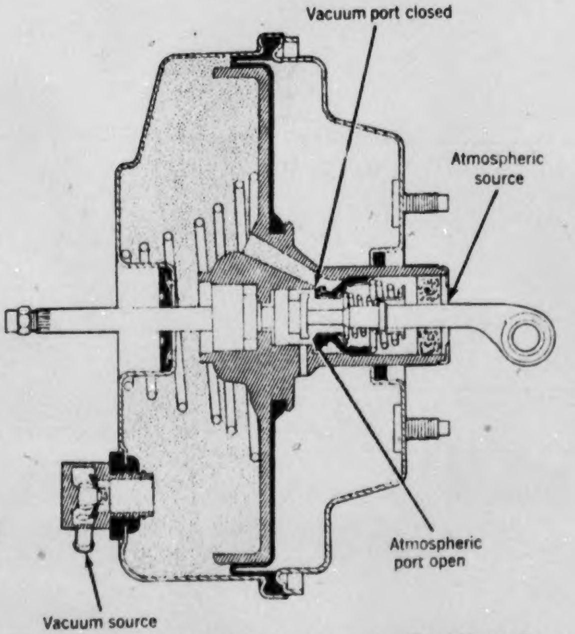


Figure .5 Booster in the applied position (Ford Motor Company).

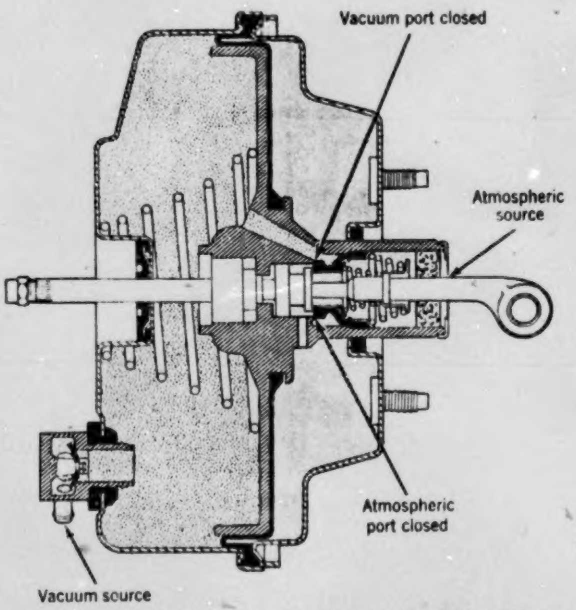


Figure 6 Booster in the holding position (Ford Motor Company).

fitted between the diaphragm and the pushrod. When the brakes are applied, the reaction device transfers a small percentage of the pushrod output force back through the valve rod to the brake pedal. The transferred force is proportional to the force applied to the master cylinder piston. It enables the driver to judge how much force must be applied to the pedal.

Brakes - Master Cylinder, Power Boost, Control Valves

No. E-4 Power Boost

Worksheet # 1

Name ______________________ Date __________ Grade ________

IDENTIFY THE OPERATING POSITIONS OF A VACUUM SUSPENDED POWER BRAKE BOOSTER

Satisfactory Performance
A satisfactory performance on this job requires that you do the following:

1. Identify the positions of a booster unit by placing the number of each position in front of the words that describe the condition of the control valve.
2. Correctly match the three positions with the control valve conditions within 10 minutes.

Performance Situation
1. Released position
2. Applied position
3. Holding position

Booster Positon	Valve Conditions	
	Vacuum Valve	Atmospheric Valve
__________	Open	Open
__________	Closed	Closed
__________	Open	Closed
__________	Closed	Open

Instructor's Initials ________

Brake - Master Cylinder, Power Boost, Control Valve

No. E-4 Power Boost

Information Sheet # 2

Tandem Diaphragm Booster

Tandem diaphram booster are vacuum suspended boosters that use two diaphragms. The diaphragms are mounted in tandem,'or one behind the other, as shown in Fig. 7.

Both diaphragms share a common shell, but they are sparated by a partition, or center plate. The two diaphragms double the area against which atmospheric pressure can push. This provides a very high output force with little pedal effort on the part of the driver.

The operation of tandem diaphragm boosters is the same as that of single diaphragm boosters. The two types of boosters are tested in the same manner. All the differences between them are internal.

Because safety is the most important consideration in the operation of any part of a brake system, all power assist units provide a fail-safe feature. The valve rod is directly in line with the pushrod, and if sufficient effort is applied by the driver, it will force the diaphragm forward. This moves the pushrod and applies the brakes even if the booster unit fails. The driver becomes aware of any such failure as the pedal effort required to stop greatly increases.

Booster Unit Overhaul

Most power assist units require the use of special tools and spring retaining devices for disassembly and assembly. Some manufacturers advise against any attempt to overhaul these units and do not list parts for them in their catalogs. For these reasons, most mechanics usually replace a faulty booster unit with a new unit or with one that has been overhauled by a shop that specializes in rebuilding booster units.

If you have to overhaul a power assist unit, you should first study the procedure outlined by the unit manufacturer. Proceed only if the proper tools and equipment are available. Any attempt to disassemble a booster unit without using the proper tools and holding devices may release spring-loaded parts and cause you personal injury.

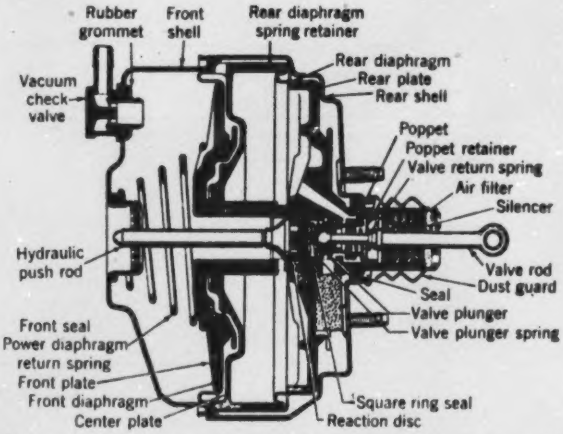

Rubber grommet
Front shell
Rear diaphragm spring retainer
Rear diaphragm
Rear plate
Rear shell
Vacuum check valve
Poppet
Poppet retainer
Valve return spring
Air filter
Silencer
Hydraulic push rod
Valve rod
Dust guard
Seal
Valve plunger
Valve plunger spring
Front seal
Power diaphragm return spring
Front plate
Front diaphragm
Center plate
Square ring seal
Reaction disc

Figure .7 A tandem diaphragm booster (General Motors).

Brakes - Master Cylinder, Power Boost, Control Valve

No. E-4 Power Boost

Worksheet # 2

Name ______________________________ Date ____________ Grade __________

Checking a Vacuum Booster

You can quickly check the operation of a vacuum booster unit in the following manner:

1. With the car engine turned off, depress the brake pedal several times. This action "bleeds off" any vacuum that may be present in the booster system.
2. Maintain a light pressure on the brake pedal and start the engine. If the booster is operating properly, the pedal will drop slightly under your foot. If no drop is felt, the booster unit is not operating.

Before you replace what may appear to be a defective booster unit, you should inspect the vacuum lines and hoses and their connections. Since the difference in pressure that causes the diaphragm to move depends on intake manifold vacuum, any restriction or leak in the connecting vacuum lines and hoses affects booster operation. A kink often causes a restriction whereas a loose connection or a cracked hose leaks. A quick inspection of the vacuum hoses and their connections could save you a lot of time.

As the engine is the source of vacuum, you should connect a vacuum gauge to the intake manifold so that the vacuum can be measured. Check the shop manual for the procedure and specifications for the car on which you are working. A reading lower than that specified could indicate a need for new manifold gaskets or for other engine repairs. If a low reading is obtained, further diagnosis of the brake system should be halted until any needed engine work has been performed. Continue your checks when the manifold vacuum is at an acceptable level.

If the vacuum reading at the manifold is satisfactory, the vacuum hose should be disconnected from the booster check valve, and the gauge should be installed on the hose. Any drop in vacuum measured at this point usually indicates a leak in the connecting lines or hoses.

A continuous hissing noise at the valve rod behind the brake pedal may be caused by a leaking diaphragm or a defective valve. In either case the booster unit must be overhauled or replaced.

Instructor's Initials ______________

Brakes - Master Cylinder, Power Boost, Control Valve

No. E-4 Power Boost

Worksheet # 2
Page 2

Name______________________________ **Date**______________ **Grade**________

CHECK THE OPERATION OF A BRAKE BOOSTER

Satisfactory Performance
A satisfactory performance on this job requires that you do the following:

1. Perform the checks listed below on the car assigned.
2. Finish the checks and list your findings in the "Performance Record" within 15 minutes.

Performance Record

1. Check the operation of the booster. Did the pedal drop when the engine was started?
2. Check the condition of the vacuum lines. Are the lines tight and in good condition?
3. Check for leakage. Are there any air or fluid leaks?
4. Do you consider the booster unit serviceable in its present condition?
5. What service do you recommend, if any?

Information

Vehicle identification

Instructor's Initials__________

Brakes - Master Cylinder, Power Boost, Control Valve

No. E-4 Power Boost

Worksheet # 3

Name___________________________________**Date**_______________**Grade**_________

REMOVAL AND INSTALLATION OF VACUUM BOOSTER UNITS

For removing, adjusting, and installing a typical vacuum suspended booster unit, you should consult an appropriate manual. Here is the general procedure for removal.

Removal

1. Remove the bolts or nuts that secure the master cylinder to the front shell of the booster unit.
   Note: On some cars you will not have to disconnect the brake lines. Usually you can pull the master cylinder away from the booster unit until the pushrod is clear. Use care so as not to kink or strain the tubing.
2. Disconnect the vacuum hose from the check valve.
3. Remove the bolt or pin that secures the valve rod to the brake pedal linkage.
4. Remove the bolts or nuts that hold the booster unit to the firewall.
5. Remove the booster unit by lifting it upward and forward.
   Push Rod Adjustment. Before installing any booster unit, either new or rebuilt, you should check the pushrod length. If the pushrod length does not match the specifications of the car maker, it must be adjusted. A rod that is too long holds the master cylinder piston forward. The piston blocks the compensating ports, causing the brakes to drag and eventually to lock. If the rod is too short, the driver has to depress the brake pedal too far before brake application begins.

The general procedure for pushrod adjustment is as follows:

1. Consult an appropriate manual for the proper pushrod length.
2. Using a piece of stiff cardboard, fabricate a gauge as shown in Fig. 8. Dimension "A" must be the pushrod length specified by the manufacturer.
3. Hold the gauge against the booster shell as shown in Fig. 9. The gauge should make even contact with the shell and the booster screw.
4. If the adjustment is incorrect, turn the screw to gain the proper adjustment. Be sure to hold the pushrod as shown in Fig. 10.

Instructor's Initials __________

Brakes - Master Cylinder, Power Boost, Control Valve

No. E-4 Power Boost

Worksheet # 3

Page 2

Name____________________________________ Date________________ Grade________

Installation

The general procedure for installing a vacuum booster unit is:

1. Place the booster unit in position.
2. Start the bolts or nuts, taking care that the valve rod is aligned with the pedal linkage.
3. Tighten the bolts or nuts.
4. Install the pin or bolt that connects the valve rod to the pedal linkage.
5. Install the vacuum hose.
6. Position the master cylinder on the front shell of the booster unit, and install the nuts or bolts.
   Note. If you have disconnected any lines or hoses in the hydraulic system, you must bleed the system.
7. Test the operation of the booster unit.

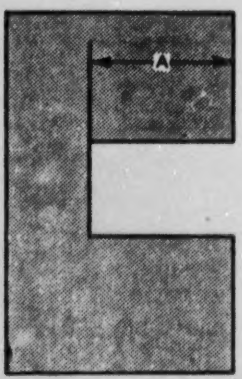


Figure 8 A pushrod gauge (Ford Motor Company).

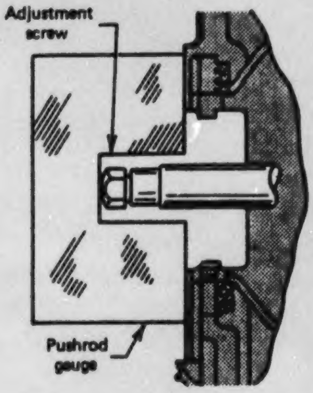


Figure 9 The use of a pushrod gauge (Ford Motor Company).

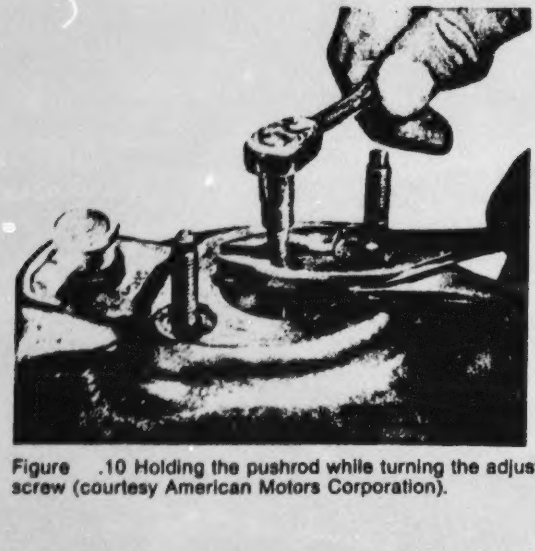


Figure .10 Holding the pushrod while turning the adjusting screw (courtesy American Motors Corporation).

Instructor's Initials________

Brakes - Master Cylinder, Power Boost, Control Valve

No. E-4 Power Boost

Worksheet # 3
Page 3

Name____________________________________**Date**________________**Grade**________

REPLACE A VACUUM BOOSTER UNIT

Satisfactory Performance

A satisfactory performance on this job requires that you do the following:

1. Replace a vacuum booster unit on the car assigned.
2. Following the steps in the "Performance Outline" and the manufacturer's procedure and specifications, complete the job within 150 percent of the manufacturer's suggested time.

Performance Outline

1. Remove the master cylinder from the booster.
2. Disconnect the vacuum line.
3. Disconnect the valve rod from the pedal linkage.
4. Remove the booster.
5. Check the push rod length and adjust it if needed.
6. Install the booster.
7. Connect the valve rod to the linkage.
8 Install the vacuum line.
9. Install the master cylinder.
10. Test the operation of the unit.

Information

Vehicle indentification

Instructor's Initials__________

Hydraulically Operated Brake Boosters

Some cars, especially those equipped with four-wheel disc brakes, are fitted with a hydraulically operated booster unit: The pressure to operate the unit is provided by the power-steering pump. This unit fits in the place normally occupied by a conventional vacuum booster unit, and it serves the same function. It increases the force a driver exerts on the brake pedal, and it applies that force to the piston of a master cylinder. A typical hydraulically operated booster is shown in Fig. 11.

Construction. A typical hydraulically operated booster contains the following assemblies:

1. A sliding valve that regulates the pressure during braking.
2. A system of levers that moves the valve when the driver depresses the brake pedal.
3. A boost piston that provides the output force to the master cylinder pushrod.
4. A reserve system.

   Note. The reserve system consists of an accumulator that stores a small amount of fluid under pressure. The stored fluid makes possible a few powered brake applications if for some reason pressure from the power steering pump becomes unavailable.

The assemblies of a typical hydraulically operated booster are shown in Fig. 12.

Operation. When the brake pedal is in the released position, the spool-shaped valve is held open by a spring. The valve controls two passages. One passage allows the fluid from the power steering pump to flow directly to the power steering gear. The fluid pressure is not applied to the boost chamber. The other passage provides an opening from the boost chamber to a line that runs back to the power steering pump reservoir so that the chamber cannot maintain any pressure.

When the brake pedal is depressed, the input rod starts operating the lever system. The lever system moves the valve, admitting fluid to the boost chamber and, at the same time, closing the passage to the pump reservoir. This allows pressure to build up in the boost chamber. As the pressure increases. it forces the boost piston forward. The movement of the boost piston is transmitted to the master cylinder piston through the output rod.

When the brake pedal is released, the valve returns to the open position. In that position the valve cuts off the fluid pressure to the boost chamber and allows the pressure in the chamber to escape through the line to the reservoir.

The reserve system accumulator is filled by pump pressure, which forces fluid into the accumulator cylinder. The fluid forces a piston down in the cylinder bore against a very strong coil spring. A system of check valves keeps the accumulator filled and pressurized. The accumulator stores enough fluid under pressure to provide for two or three stops without benefit of fluid from the power steering pump. After the fluid in the accumulator has been depleted, the brakes can still be applied. But the pedal effort required is greatly increased.

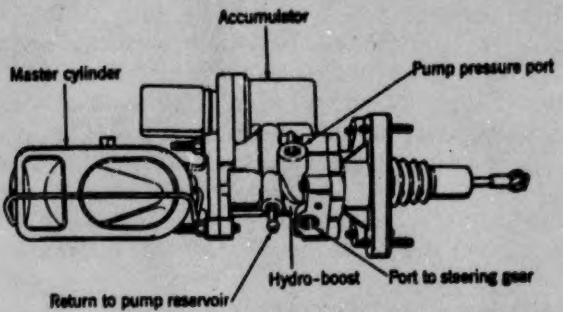

Accumulator
Master cylinder
Pump pressure port
Hydro-boost
Port to steering gear
Return to pump reservoir

Figure .11 Top view of a hydraulically operated brake booster (Ford Motor Company).

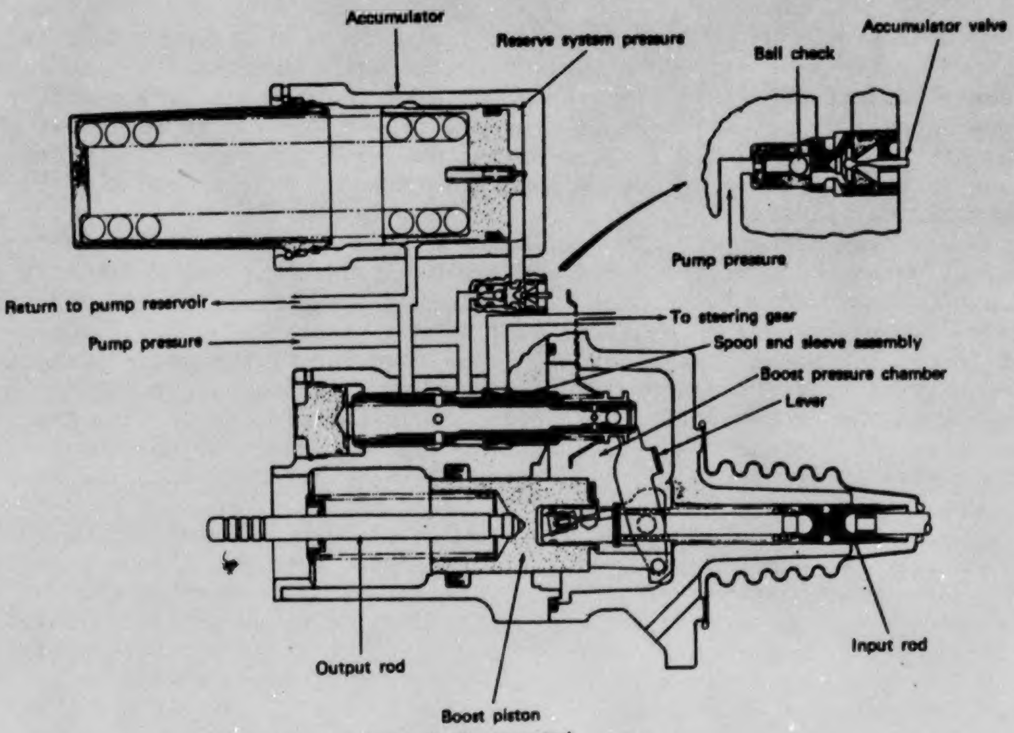

Accumulator
Reserve system pressure
Ball check
Accumulator valve
Pump pressure
Return to pump reservoir
Pump pressure
To steering gear
Spool and sleeve assembly
Boost pressure chamber
Lever
Input rod
Output rod
Boost piston

Figure 12 A sectional view of a hydraulically operated brake booster (Ford Motor Company).

HYDRO-BOOST GENERAL SERVICE PROCEDURE

Removing the Hydro-Boost From the Vehicle

1. With the engine off, depress the brake pedal several times to discharge the accumulator.
2. Remove master cylinder from hydro-boost unit. (Do not apply booster with m/cyl. removed)
3. Disconnect all three (3) hydraulic lines from booster.
4. Disconnect pedal or input rod.
5. Remove booster mounting nuts or bolts.

Re-installing the Hydro-Boost in the Vehicle

1. Install unit on mounting surface.
2. Re-connect pedal or input rod.
3. Install and tighten mounting nuts.
4. Re-connect master cylinder.
5. Re-connect all three (3) hoses.
6. Bleed hydro-boost unit as follows:
   a) Fill pump reservoir
   b) Crank engine for several seconds, with coil wire disconnected. (Do not start engine)
   c) Check fluid level; add if necessary.
   d) Start engine.
   e) Turn wheels lock-to-lock twice.
   f) Stop engine.
   g) Discharge accumulator. (Depress brake pedal 5 times)
   h) Repeat steps d) and e).
   i) If foaming occurs, stop engine and wait for 1 hour for foam to dissipate.
   j) Repeat steps d) and e).

The hydro-boost is generally self-bleeding, and the above procedure will normally bleed the air from the booster. Normal driving and operation of the unit will remove any further trapped air.

Brakes - Master Cylinder, Power Boost, Control Valve

No. E-4 Power Boost

Worksheet # 4

Name________________________________ **Date**_______________ **Grade**________

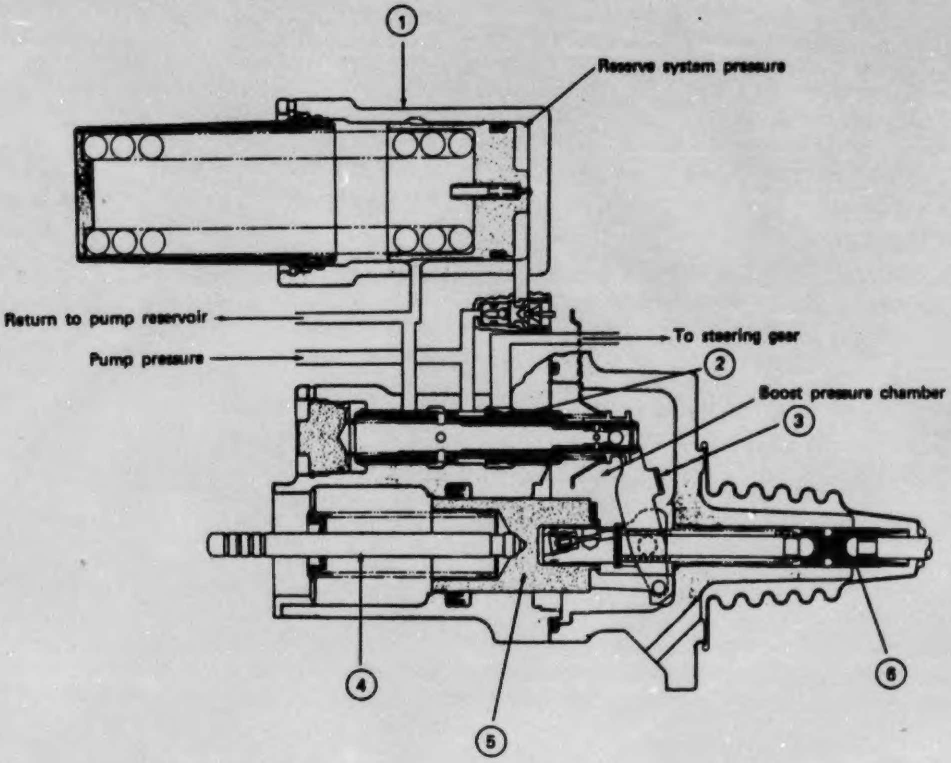
IDENTIFY THE MAJOR COMPONENTS OF A HYDRAULICALLY OPERATED BRAKE BOOSTER

Satisfactory Performance

A satisfactory performance on this job requires that you do the following:

1. Identify the major components of a hydraulically operated brake booster unit by matching the numbered parts on the drawing with the list of part names.

Performance Situation


①
Reserve system pressure
Return to pump reservoir
Pump pressure
To steering gear
②
Boost pressure chamber
③
④
⑤
⑥

_______________ Boost piston

_______________ Spool and sleeve valve

_______________ Accumulator

_______________ Input pushrod

_______________ Pressure arm

_______________ Reserve valve

_______________ Lever

_______________ Output pushrod

Instructor's Initials _______________

Auto Mechanics
Master Cylinder, Power Boost, Control Valves
No. E-5 Anti-Skid

OBJECTIVE: Upon completion of this unit you will be able to identify the functions of the parts in an anti-skid device.

EXPLANATION:

MATERIALS NEEDED: Safety glasses

TOOLS NEEDED:

References		Do	
#1.	--	#1.	Read text
#2.	pp. 360-361	#2.	Read information sheets
#3.	--	#3.	Complete worksheets
#4.	--	#4.	Check with instructor
#5.	--	#5.	Take the test
#6.	pp. 584-587		
#7.			
#8.			

Antiskid Devices

You are already aware of the importance of the friction between the brake linings and the drums or rotors. Equally important is the friction between the tires and the road. If the friction between the brake linings and the drums or rotors is greater than the friction between the tires and the road, the tires skid.

Many factors contribute to a skid. Among them are tire condition, road condition, brake condition, the way in which the brakes are applied, and weight shift during braking. Some of those factors can be controlled, but some cannot. The car owner can replace worn tires and maintain the proper tire pressure but cannot control the condition of the road. A mechanic can provide and maintain an efficient braking system but cannot prevent situations that require panic stops.

Neither the car owner nor the mechanic can control weight shift. As stated earlier, the center of gravity of a car shifts forward during braking. This shift places more of the car weight on the front tires than on the rear tires. The extra weight increases the coefficient of friction between the front tires and the road. At the same time, the weight removed from the rear tires decreases the coefficient of friction between them and the road. Because of this, the rear tires are more apt to skid than the front tires.

A tire that is skidding can slide in any direction. A slight bump or dip in the road surface can easily cause the rear end of a skidding car to swerve to one side. Since the rear wheels cannot be steered, the direction in which the car moves may be uncontrollable. Even if the direction of movement can be maintained, the stopping distance is usually increased. It is increased because the friction between the tire and the road is usually less when the tire is sliding than when it is rolling. This decrease in friction is especially noticeable on wet or icy roads.

Of course, skidding can be very dangerous. For this reason, antiskid devices are added to many brake systems. Such devices (1) maintain the directional stability of a car, and (2) decrease the required stopping distance.

Most antiskid devices use a small computer to determine the proper amount of braking for each situation. The computer measures the difference between the rate of deceleration of a rotating wheel and the rate of deceleration of the car. This difference is usually referred to as slip. If the car is traveling 60mph and the wheel is going 50 mph, there is a slip of about 15 percent. The most efficient braking is obtained within the slip range of 10 to 20 percent. When the slip is less than 10 percent, the stopping distances increases. When the slip exceeds 20 percent, the wheel usually locks and skids.

Optimal braking is obtained when the slip range of 10 to 20 percent is maintained throughout the entire period of braking. During normal braking on dry, well-paved road surfaces, a skilled driver can maintain this slip range by applying just the right amount of force to the brake pedal. However, it is impossible for any driver to maintain this slip range during a panic stop, especially if the road surface is wet or icy.

Antiskid devices maintain the proper slip range automatically. They do so by pumping the brakes from 3 to 5 times per second whenever a rear wheel begins to lock under heavy braking.

This way the locking point is never reached, or if it is reached, the brakes are released so fast that the wheel does not actually stop turning. This action allows the wheels to keep turning even though the brakes are applied as tight as possible.

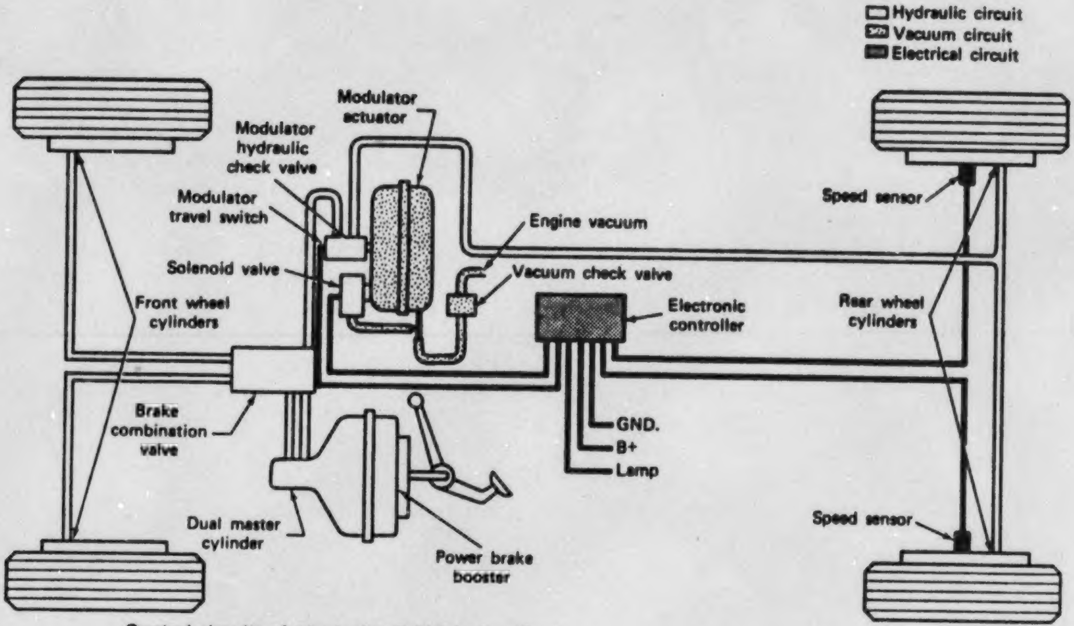
Components

A typical antiskid device contains three major components: (1) sensors, (2) a computer, and (3) an actuator.

The Sensors. The sensors detect the speed of the wheels and communicate it to the computer by means of a signal. Some systems use a sensor mounted at each rear wheel. Other systems use a single sensor mounted at the rear of the transmission. Still other systems use a similar sensor mounted at the differential pinion. This type sensor detects the average speed of both rear wheels.

The Computer. The computer, sometimes called the controller, receives the signal from the sensor or sensors. From the signal, it determines when the wheel is about to lock. It then determines the correct braking cycle and transmits this information to the actuator.

The Actuator. The actuator is an electrically triggered device that pumps the brakes. It is made up of several subassemblies. They function to allow the alternate use of engine manifold vacuum and air pressure to produce the pumping action.


☐ Hydraulic circuit
▨ Vacuum circuit
■ Electrical circuit
Modulator actuator
Modulator hydraulic check valve
Modulator travel switch
Solenoid valve
Engine vacuum
Vacuum check valve
Front wheel cylinders
Electronic controller
Speed sensor
Rear wheel cylinders
Brake combination valve
GND.
B+
Lamp
Dual master cylinder
Power brake booster
Speed sensor

Control circuits of a typical antiskid device (General Motors).

Operation. Antiskid devices operate only when a wheel starts to lock. When braking is gradual, the wheels decelerate relatively slowly without locking. The slow change of the signal from the sensor or sensors to the computer indicates that the wheels are coming to a stop within a normal range of deceleration. This range is acceptable to the computer, which sends no signal to the actuator. As long as braking is such that the slip rate does not exceed about 15 percent, the computer does not send a signal. Therefore, the actuator does not pump the brakes.

Whenever a rear wheel starts to lock, the wheel decelerates abruptly. The rapid change in the signal to the computer indicates that a skid is about to occur. The computer then sends a signal to the actuator, and the actuator does two things.

1. It closes a valve between the master cylinder and the rear brake system. This traps the pressure in the rear brake system, preventing the pumping action of the actuator from causing the brake pedal to pulsate.
2. It moves a piston outward from a chamber, or cylinder. Since the chamber is part of the hydraulic system for the rear brakes, the volume of the system is increased. The increased volume decreases the pressure in the rear brake system.

When the pressure in the rear brake system is decreased, the brakes release slightly. This allows the wheel to accelerate. As the speed of the wheel approaches the speed of the car, the computer receives a "normal" signal from the sensor, and it stops signalling the actuator. The actuator moves the piston back into the cylinder. The pressure is restored, and the wheel again begins decelerating. This action occurs very fast. The entire cycle, from the partial pressure release to full pressure and back to partial release, happens in one-fifth to one-third of a second. The cycle continues as long as the wheel tends to lock. If the driver hold full force on the brake pedal throughout a stop the antiskid device functions until the car speed drops to about five mph. Then the device disengages. If the driver eases off on the brake pedal at any time during the stop, the device instantly disengages.

Service. Service on antiskid devices is based entirely on the diagnosis of a particular problem. The diagnosis consists of operational checks and electrical-resistance checks in a certain sequence and to specifications set by the manufacturer of the particular device being checked. Before attempting to service any antiskid device. you should study the manual covering that particular device.

Brakes - Master Cylinder, Power Boost, Control Valve

No. E-5 Anti-Skid

Test #1

Name______________________________________Date____________Grade______

IDENTIFY THE FUNCTION OF THE PARTS IN AN ANTISKID DEVICE

Satisfactory Performance

A satisfactory performance on this job requires that you do the following:

1. Identify the functions of the components of an antiskid device by placing the number of each component in front of the component function.

2. Correctly match the three components with their functions.

Performance Situation

1. Sensor
2. Computer
3. Actuator

__________ determines when a wheel is decelerating too rapidly.

__________ sends a signal to the actuator.

__________ sends a signal to the computer.

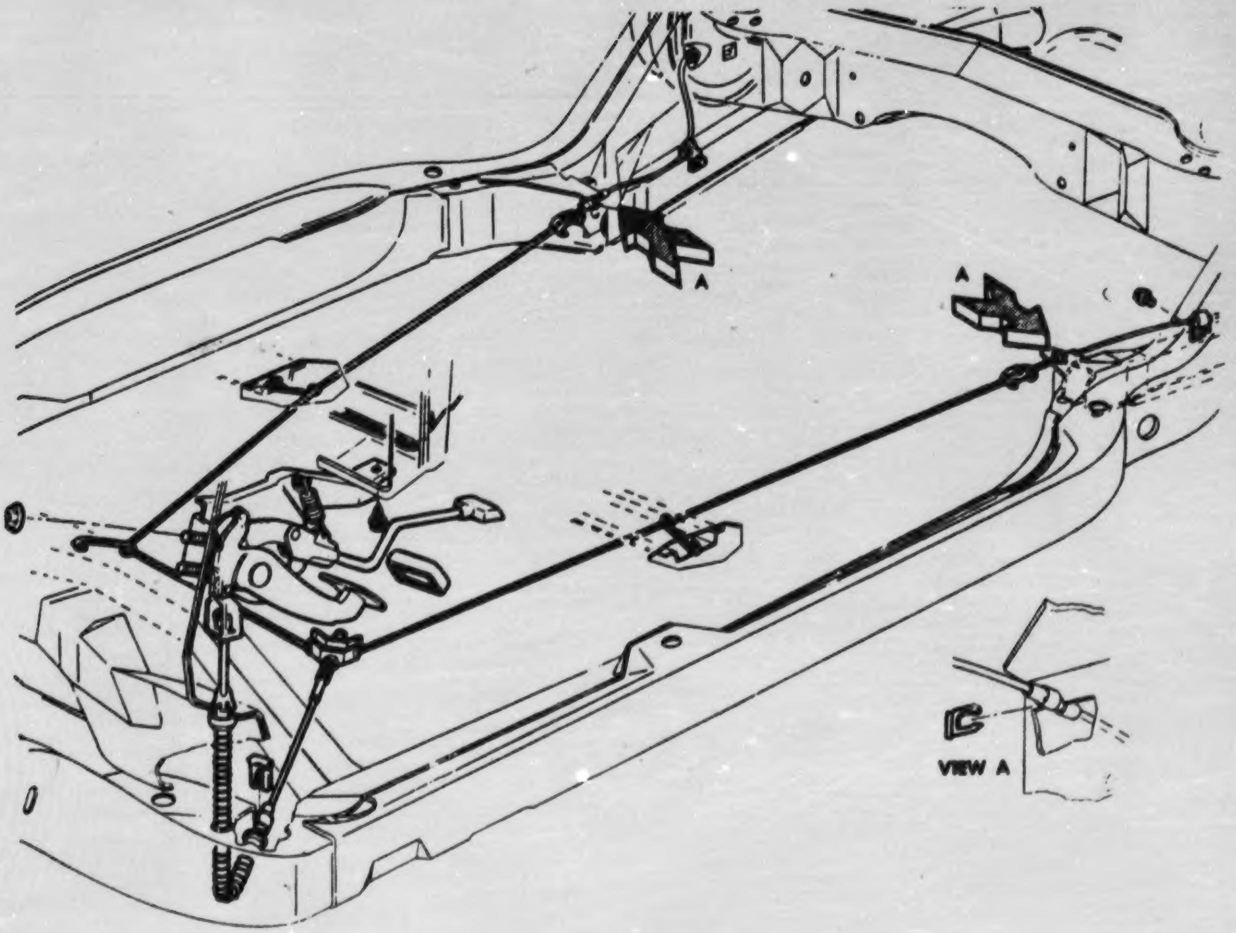
__________ shuts off the rear brake system from the master cylinder.

__________ pumps the brakes at the rear of the car.

__________ indicates wheel speed.

__________ controls intake manifold vacuum and atmospheric pressure.

PARKING BRAKE SYSTEM



REFERENCE

The texts chosen were selected because they are in current use by the instructors who compiled this manual. You should have a copy of at least one in your shop.

The text books are to be used as references for each exercise in this book. For each exercise you will find a number followed by page numbers. Look up the book number on this list and the page numbers will correspond to the exercise on which you are working. For example, if you find #4. 103-111 in the reference section, you would check this reference list and find that book No. 4 is Auto Mechanics by H. E. Ellinger. In that book, pages 103-111 will apply to the exercise you are working.

	TEXT	AUTHOR	PUBLISHER
1.	Auto Service and Repair 1975	Stockel	Goodheart - Willcox
2.	Auto Mechanics Fundamentals 1974	Stockel	Goodheart - Willcox
3.	Automotive Encyclopedia 1975	Toboldt - Johnson	Goodheart - Willcox
4.	Auto Mechanics 1977 Second Edition	Ellinger	Prentice - Hall
5.	Automotive Mechanics 1970 Sixth Edition	Crouse	McGraw - Hill
6.	The Auto Book 1974	Crouse	McGraw - Hill

Auto Mechanics
Parking Brakes
No. F-1

OBJECTIVE: After completing this unit, the student will be able to identify the parts and function of the parking brake system. Along with the replacement and adjustment of the components.

EXPLANATION: Because of the importance in having a good parking brake system, the student will be expected to adjust and inspect at least one of the three different types of parking brakes.

MATERIALS NEEDED: Safety glasses, manufacturer's specification manual.

TOOLS NEEDED: Miscellaneous brake tools, lug wrench, safety stands, miscellaneous hand tools.

References	Do
#1. pp. 23-24	# 1. Read assigned references.
#2. pp. 355-356	# 2. Complete worksheets.
#3. p. 518	# 3. Inspect and adjust at least one parking brake system.
#4. p. 430	
#5. p. 515	
#6. pp. 591-592	
#7.	
#8.	

AUTO MECHANICS

PARKING BRAKES

No. F - Index

F-1 Parking Brake Systems and Components

INTRODUCTION

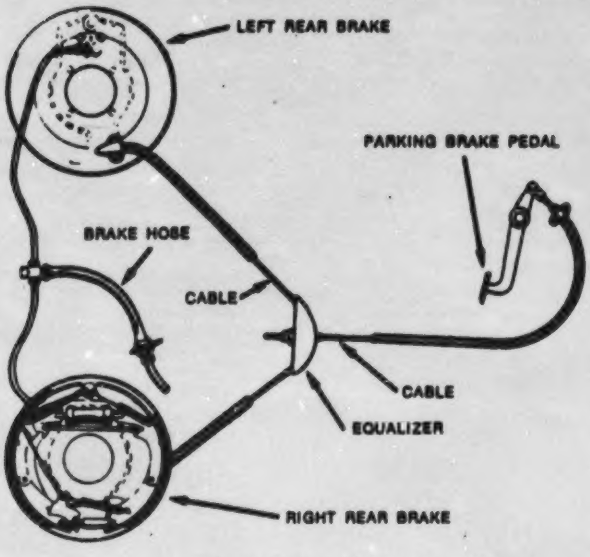
The parking brake system is mechanically designed to provide a means of holding a vehicle in a stationary position. It is not designed to stop a moving vehicle, even though it is sometimes called an Emergency Brake. Whether hand or foot operated, parking brake systems should always be kept in good working order.

Within this section of parking brakes, we'll be looking at three types:

1. Integral Parking Brake - part of regular car wheel brakes.
2. Auxiliary Drum Parking Brake - used in conjunction with a car disc brake.
3. Transmission Parking Brake - independent of the car wheel brakes.

Integral Parking Brake

The figure below shows the portion of the parking brake system from the brake pedal to the rear wheel brake. This is the system used by most manufacturers that expands the rear brake shoes inside their drums. When the parking brake is applied, a balanced pull is transmitted through the equalizer, and car cables to the brake shoes to form tight contact with the drums. The shoes are held in this position until the parking brake pedal is released.



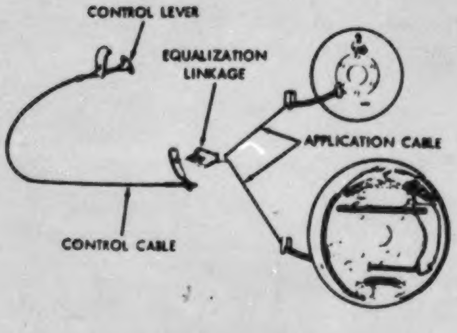
Typical Integral Parking Brake

Operation and Servicing

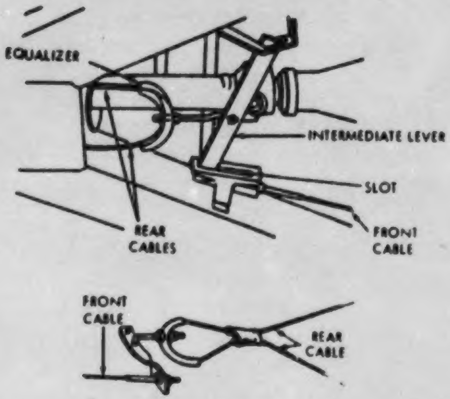
Unless the vehicle has a separate parking brake, the rear brake shoes also are used for parking and are then operated by a cable system. A front cable is attached to the foot pedal or hand grip and to an equalizer near the middle of the car, beneath the floor pan. Two cables are attached in the left rear and right rear brakes, and are connected to the equalizer which divides the applying force evenly to each brake. Each rear cable enters the rear brake through a conduit. The cable end is engaged with the lower end of a parking brake lever. This lever is hinged to the web of the secondary shoe and linked with the primary shoe by means of a strut. Thus the lever and strut expand both shoes away from the anchor and wheel cylinder and into contact with the drum as the cable and lever are drawn forward. The shoe return springs re-position the shoes when the cable is slacked.

A schematic of a rear axle cable operated parking brake with a control lever is shown and typical equalizer arrangements are shown below.

In order to remove and replace the rear brake shoes, it may be necessary to relieve the cable tension by backing off the adjusting check nut(s) at the equalizer. Count the turns backed off in order to restore the nuts to their original position. Although the specified cable adjustments depend on the vehicle model, only simple tightening adjustments are needed to take up the slack caused by the cable stretch. This is done at the equalizer. If a front cable must be adjusted, do this first. Then engage the operating lever at least one notch before adjusting the rear cables. This helps avoid over-tightening which would expand the brake shoes into contact with their drums.



Rear Axle Cable Operated
Parking Brake With a Control Lever



Typical Equalizer Arrangements

Auxiliary Drum Parking Brake

There are two ways to utilize a rear disc brake in conjunction with the parking brake. They are a disc and drum type and the Kelsey-Hayes type.

(A). Rear Disc/Drum Parking Brake

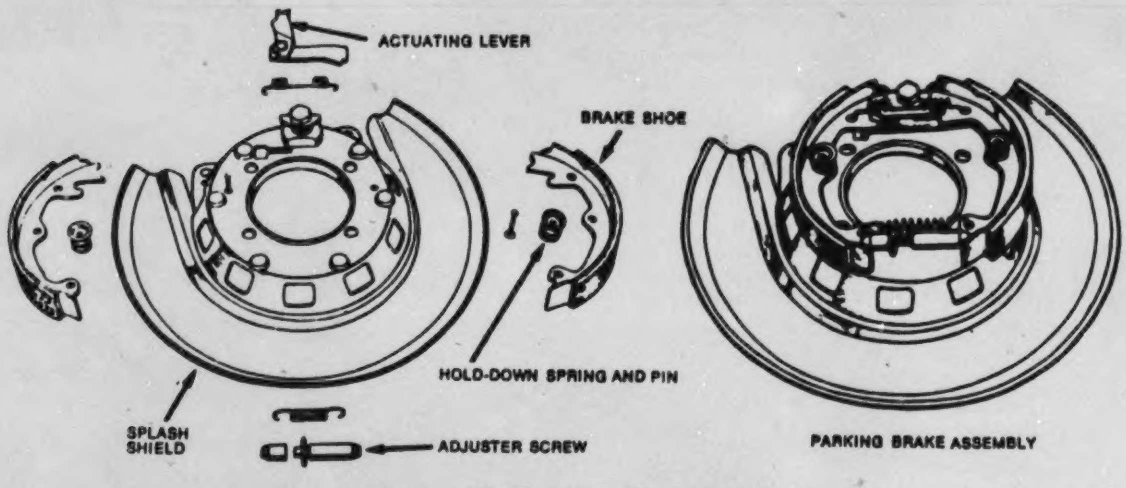
The parking brake on the car equipped with rear disc brakes is slightly different from other integral parking brakes, or from the cars equipped with rear drum brakes. All Corvettes since 1965, some Camaros and Imperials since 1974 have four-wheel disc brakes with drum type parking brakes. The inside of each rear wheel hub and rotor assembly is used as the parking brake drum. The figure below shows a typical rear disc parking brake.

The cable operated parking brake is a small 6 1/2" (165 mm) diameter servo type brake with a star wheel adjuster. It is located within the rotor hub which also acts as the brake drum. Remove the wheel to expose the star wheel access hole in the hub. The adjustments are similar to the integral type parking brake.

Regular wheel brake service should be completed before adjusting the parking brake. In particular, this type of parking brake should be checked for:

1). Free movement of the parking brake cables in the conduits. A lubricant to free the cables, if necessary, should be applied.
2). Worn equalizer and linkage parts. Any defective parts should be replaced.
3). Broken strands in the cables. Any cable with broken strands or signs of wear should be replaced.

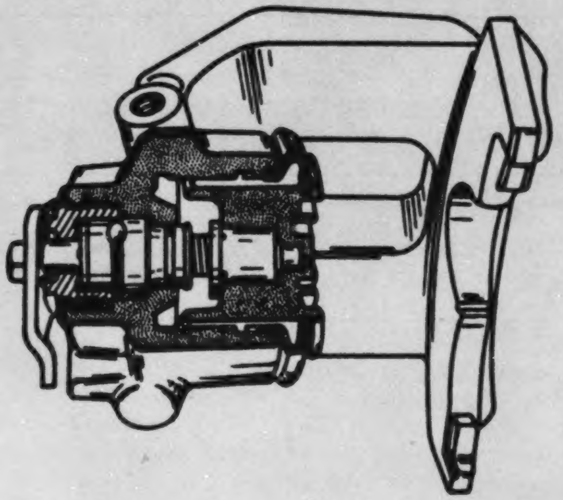
In order to adjust the parking brake, the parking brake pedal or lever should be applied to the first notch. Then to remove all slack, adjust the cables at the equalizer. When the parking brake pedal or lever is released, there should be no drag at the rear wheels.



Typical Rear Disc Parking Brake

(B). Rear Disc Parking Brake

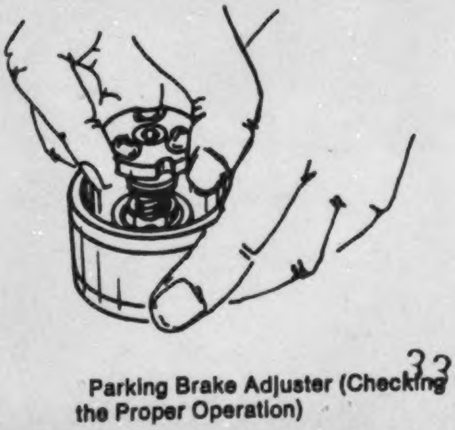
A sectional view of the Kelsey-Hayes sliding caliper rear disc brake as used on Ford Motor Company vehicles is shown below. The parking brake is a part of the regular brake, only a mechanical lever works on the ball and ramp device within the parking brake.



Cross-section of Rear Disc Brake
(Kelsey-Hayes Type)

Check the adjuster operation by first assembling the thrust screw into the piston assembly. As shown below, pull the two pieces apart by hand, approximately 1/4" (6 mm) and then release them.

When pulling on the pieces, the brass drive ring must be stationary, causing the nut to rotate. When releasing the two parts, the nut must remain stationary and the drive ring must rotate. The piston and adjuster assembly should be replaced, if the action of the components does not follow this pattern. Then the ball pockets, threads, grooves, balls, anti-rotation pin, the lever, etc. should be inspected for wear or damage, and should be replaced, if necessary.



Parking Brake Adjuster (Checking the Proper Operation)

The thrust screws and operating shaft are not interchangeable from side to side, due to the ramp direction of the ball pockets. The pocket surface of the operating shaft and the thrust screw are stamped with the proper letter, R or L., indicating part usage.

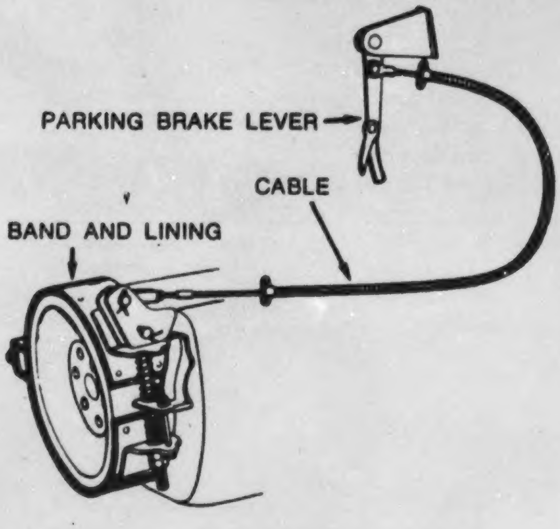
The balls should be placed in each of the three pockets of the thrust screw. Liberal amounts of SILICONE GREASE should be applied to all components of the parking brake mechanism. The operating shaft goes on the balls, and the thrust bearing on the operating shaft. The parking brake lever must rotate freely after torquing the end retainer to about 75-95 ft. lb. (102-129 N·m). While installing the parking brake lever on its keyed spline, the lever arm must point down and rearward. The lever retainer screw should be torqued to 16-22 ft. lb. (22-30 N·m).

Transmission Parking Brake

There are two different types of transmission parking brakes, both of which are completely separate from the basic brake system.

(A). External Band Brake

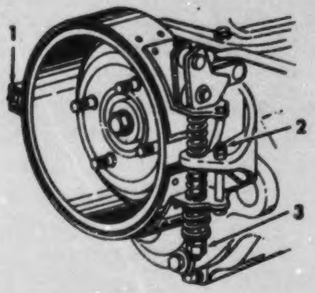
As shown below, this brake consists of a drum, normally attached to the drive shaft and an external band. The lining is attached to the inside of the band. The lever arrangement acts to squeeze the band on the brake drum and keeps the drum and drive shaft from turning. This keeps the rear wheels from turning and holding the car in place.



External Band Parking Brake

Adjustment Procedure

1). Cut the locking wire and adjust screw (1) to provide 0.020"-0.030" (0.51-0.76 mm) clearance between the lining and the drum.
2). Loosen the lock nut on the adjusting nut (2) and rotate the nut (2) until the clearance at the lower portion of band clears the drum 0.020"-0.030" (0.51-0.76 mm). Tighten the lock nut.
3). Rotate the nut (3) until the clearance at the top of the band is 0.020"-0.030" (0.51-0.76 mm).
4). Recheck that the three positions mentioned and readjust if necessary.
5). Install the lock wire in the screw (1).



Adjustment of the External Band Parking Brake

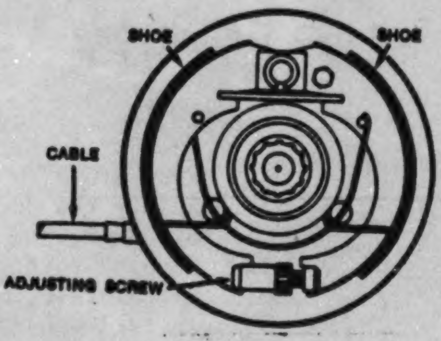
To adjust the cable:

6). Loosen the clevis lock nut, remove the pin, and take up the yoke on the threads to remove all slack, until the clevis can just be installed. Replace the pin and tighten lock nut.

CAUTION: Always check for proper band adjustment before adjusting the cable.

(B). Internal Shoe Brake

As illustrated, this brake consists of a drum that is attached to the drive shaft and a shoe brake assembly normally supported at the rear of the transmission. The brake shoes are mechanically adjusted by a lever or a cam inside the assembly. This type was mostly used on the Chrysler models (Dodge, De Soto, Plymouth) from 1951-62.



Adjustment Procedure

1). Place the transmission control in neutral and release the hand brake.

2). Jack one of the rear wheels so the drum can be rotated by hand.

3). Remove the adjusting screw cover at the lower edge of the brake shield. This cover has one slotted end which permits it to be rotated to expose an access opening when the two screws are loosened.

4). Loosen the clamp bolt (1) to free the cable adjusting nut.

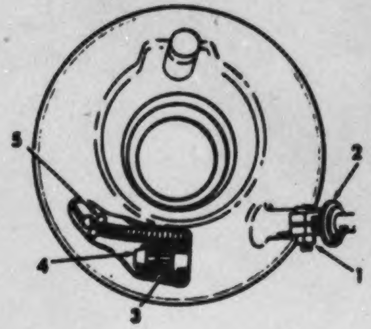
5). Back out the cable adjusting nut (2), or slide the sleeve in the clamp.

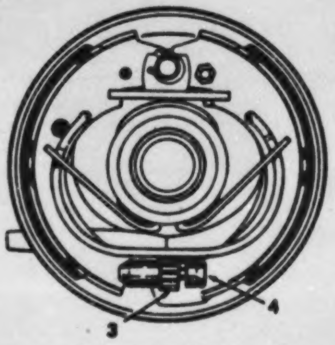
6). Expand the shoes by rotating the shoe adjusting nut (3) until the lining drags on the drum.

7). Back off the nut to provide 0.010" (0.25 mm) clearance between the linings and the drum (at least one notch of the nut).

8). Make sure the shoulders on the nut (3) are seated in the grooves in the sleeve(4).

9). On vehicles equipped with a hand control lever, rotate the cable adjusting nut (2) against the cable clamp until 0.010" (0.25 mm) clearance exists between the brake shoe cable and the operating lever, at point (5). On some models, this



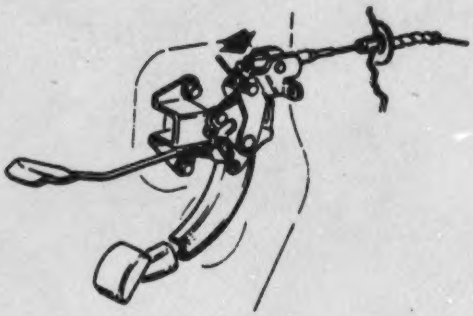


Internal Shoe Parking Brake

nut is not used and the adjustment is made by sliding the cable sleeve in or out of the clamp. On the vehicles equipped with a foot pedal control, the cable adjusting nut is located under the dash on the pedal control linkage.

10). Tighten the cable clamp bolt (1). (see previous page).

11). Pull up on the brake control lever (or depress the foot lever), which should advance four to six notches to firmly apply the brake. This is not more than half of the available travel



Foot Pedal Control—Internal Shoe Parking Brake

Brakes - Parking Brakes

No. F-1

Worksheet # 1

Name ______________________________ Date __________________ Grade ________

Circle either "T" for true or "F" for false

1). T F Levers in the system can multiply the physical effort of the driver enough to force the rear brake shoes into contact with the drums.
2). T F The main reason for designing a parking brake is to overcome the kinetic energy of a moving automobile.
3). T F A parking brake can only be diagnosed for slipping when properly applied.
4). T F Parking brake levers are attached to the secondary brake shoe of the rear brakes.
5). T F An automobile with the drum type parking brake is not as efficient when facing uphill as compared to downhill.
6). T F Before adjusting a parking brake, you should inspect the drums, rotors, pads, linings, cables, etc.
7). T F Parking brakes can be a combination disc and drum type.
8). T F Ford uses a thrust screw that pushes the caliper piston out for a mechanically operated parking brake.

Identify the following parking brake components with their function by drawing a line to the correct answers.

A. Operating lever
B. Equalizer
C. Parking brake lever
D. Link
E. Secondary shoe
F. Front cable
G. Rear cable
H. Equalizer cable

A. Provides an even pull on both rear cables.
B. Pulls the parking brake lever.
C. Pulls the front cable.
D. Transmits the movement of the parking brake lever to the primary shoe.
E. Pivots on the secondary shop.
F. Pulls the rear cables.
G. Pulls the equalizer lever
H. Provides a mounting point for the parking brake lever.

Brakes - Parking Brakes

No. F-1

Worksheet # 2

Name ______________________ Date ______________ Grade ________

Laboratory Exercise: Adjust Parking Brakes, Drum, Drum in Rotor, and mechanically Actuated Rear Calipers

1). Set the transmission shift lever and the parking brake lever in their proper positions.

2). Raise and support the car and inspect linings drums and related parts.

3). Rotate the star wheel adjuster until the shoes set against the drum.

4). Adjust parking brake cables.

5). Apply and release the brake several times.

6). Check position of the levers at the calipers (mechanical activated rear calipers only).

7). Readjust cables, if necessary.

8). Lower car.

9). Check operation of brakes.

Information

1). Vehicle identification ______________________

2). Reference and pages used ____________________

3). Location of adjustment ______________________

4). Condition of linings or pads _______________

Brakes - Parking Brakes

No. F-1

Worksheet # 3

Name ________________________ **Date** ______________ **Grade** ________

Laboratory Exercise: Replace front and rear brake cables

Front Cable

1). Disconnect the battery cable.

2). Raise and support the car.

3). Remove attached parts at the rear end of the cable.

4). Remove any support clips.

5). Disconnect the cable from the operating lever assembly.

6). Connect the replacement cable to the operating assembly.

7). Install attached parts at the rear of the cable.

8). Install any support clips.

9). Adjust the parking brake.

10). Lower the car.

11). Connect the battery cable.

12). Check the operation of the parking brake.

1). Raise and support the car.

2). Remove the wheel and drum.

3). Disconnect the cable from the equalizer.

4). Remove brake shoes.

5). Remove the cable from the backing plate.

6). Install the cable, and secure it.

7). Install brake shoes, drum, and wheel.

8). Connect the cable to the equalizer.

9). Adjust the parking brakes.

10). Lower the car.

11). Check the operation of the brake.

Information

1). Vehicle identification ______________

2). Reference and pages used ____________

3). Location of adjustment ______________

4). Condition of linings or pads _________

Brakes - Parking Brakes

No. F-1

Test

Name ______________________ **Date** ______________ **Grade** ________

Fill in or circle the correct answer for the following in the blanks provided.

1). List below the three types of mechanical type parking brakes.

A. B. C.

2). When the parking brakes are applied, the drivers effort is multiplied through

A. hydraulics
B. cables
C. lever
D. servo action

3). When brake shoes are being installed on the rear wheels of a car fitted with drum brakes, the link spring is placed between the link and the

A. primary shoe
B. secondary shoe
C. parking brake lever
D. anchor pin

4). Two mechanics are discussing parking brake systems.
Mechanic A says the service brakes should be checked and adjusted before the parking brake is adjusted.
Mechanic B says that when parking brakes are being adjusted, the operating lever should be actuated 1/2 the traveling distance. Who is right?

A. A only
B. B only
C. Both A and B
D. Neither A nor B

5). Two mechanics are discussing parking brake systems. Mechanic A says that the front brakes should be adjusted before a front brake cable secured under the instrument panel is replaced. Mechanic B says that the application of both rear brakes is equalized by the use of a link and spring. Who is right?

A. A only
B. B only
C. Both A and B
D. Neither A nor B

6). Parking brake shoes are sometimes referred to as:

A. primary and secondary shoes
B. left and right shoes
C. first and second shoes
D. large and small shoes

7). Parking brakes are properly adjusted when:

1. They are fully applied and holding after the operating lever has been moved through less than half of its possible travel
2. They are fully released when the operating lever is in the released position.

A. 1 only
B. 2 only
C. Both 1 and 2
D. Neither 1 nor 2

8). Excessive slack in the brake cables can be eliminated in most instances by an adjustment at the

A. operating lever
B. equalizer
C. star wheel adjusters
D. link

9). On some cars less effort is required to apply the parking brakes while the service brakes are held on than while the service brakes are off. This method of brake application will work on cars fitted with:

1. drum brakes
2. combination brake systems
A. 1 only
B. 2 only
C. both 1 and 2
D. neither 1 nor 2

10). On cars fitted with parking brakes that use drums in the center of the rear rotors, an access hole for the star wheel adjuster is provided in the:

1. drum
2. splash shield

A. 1 only
B. 2 only
C. both 1 and 2
D. neither 1 nor 2

11). Two mechanics are discussing parking brakes.
Mechanic A says that the axle flange should be removed before the parking brake shoes are replaced in a system that incorporates brake drums in the center of the car rotors.
Mechanic B says that in a brake of this type, the shoes are expanded by a cam. Who is right?

A. A only
B. B only
C. Both A and B
D. Neither A nor B

12). Which major automotive manufacturer uses a Kelsey-Hayes sliding caliper car disc brake

A. General Motor Co.
B. Ford Motor Co.
C. Chrysler Corp.
D. American Motors

13). Two mechanics discussing parking brakes.
Mechanic A says that a transmission type parking brake has an external brake band.
Mechanic B says that they have internal brake shoes. Who is right?

A. A only
B. B only
C. Both A and B
D. Neither A nor B

TROUBLE SHOOTING

MR. NATURAL! MY CAR WON'T STOP
BRAKES MY HEART

REFERENCE

The texts chosen were selected because they are in current use by the instructors who compiled this manual. You should have a copy of at least one in your shop.

The text books are to be used as references for each exercise in this book. For each exercise you will find a number followed by page numbers. Look up the book number on this list and the page numbers will correspond to the exercise on which you are working. For example, if you find #4. 103-111 in the reference section, you would check this reference list and find that book No. 4 is Auto Mechanics by H. E. Ellinger. In that book, pages 103-111 will apply to the exercise you are working.

	TEXT	AUTHOR	PUBLISHER
1.	Auto Service and Repair 1975	Stockel	Goodheart - Willcox
2.	Auto Mechanics Fundamentals 1974	Stockel	Goodheart - Willcox
3.	Automotive Encyclopedia 1975	Toboldt - Johnson	Goodheart - Willcox
4.	Auto Mechanics 1977 Second Edition	Ellinger	Prentice - Hall
5.	Automotive Mechanics 1970 Sixth Edition	Crouse	McGraw - Hill
6.	The Auto Book 1974	Crouse	McGraw - Hill

Auto Mechanics
Brakes - Troubleshooting
No. G

OBJECTIVE: This unit is intended to be a guide to brake system diagnosis. After completion of the information sections, you will be able to logically trace a brake problem to its source.

EXPLANATION: Diagnosis is a logical reasoning process which can be learned through a complete understanding of system fundamentals in sequence.

MATERIALS NEEDED: Safety glasses

TOOLS NEEDED:

References	Do
#1. pp. 29-33 to 29-37	#1. Study reference assignment.
#2. --	#2. Complete troubleshooting exercise.
#3. pp. 539-541	#3. Check with instructor.
#4. --	
#5. pp. 521-524	
#6. pp. 593-602	

Auto Mechanics
Brakes
No. G - Index

G-1 General Troubleshooting Sequence

G-2 Road Test

G-3 Troubleshooting Drum Systems

G-4 Troubleshooting Disc Systems

G-5 Troubleshooting Vacuum-hydraulic Power Boosters

G-6 Troubleshooting Hydro-boost Units

Brakes - Troubleshooting

No. G-1 General Sequence

Information Sheet #1
Page 1

All brake troubleshooting will involve a few common areas. Many of these can be covered during the first fifteen to thirty minutes the car is in the shop. A logical sequence is presented in chart form below. Areas with an asterisk should be checked on all vehicles, regardless of the problem being diagnosed.

*Talk to customer - what is the exact complaint? When does it happen? Is it always present, or gone sometimes?

*If vehicle has no brakes, go on to next step. If there are brakes, take a test drive.
A. Verify the customer's complaint.
B. Check the remaining items in ROAD TEST, Information Sheet #G-2-1.

*Check master cylinder fluid level and condition.

If fluid level is good, refer to troubleshooting chart, Information Sheet #G-3 & G-4, and follow diagnostic sequence.

If fluid level is down - which side of dual master? (Front brakes or rear brakes).

*Check power booster unit (see Information Sheet #G-5 & G-6).

*Lift car, visually inspect lines, hoses, cables, and all visible brake system components.

*Pull wheels, check:
A. Shoe or pad wear and condition.
B. Drum or rotor within machineable specifications.
C. Cylinder or caliper leaks.
D. Cylinder or caliper binding.
E. Hardware condition.
F. Axle seal or grease seal leaks.
G. Parking brake cable binding

*If brakes need repair, pull apart calipers and cylinders - check the clearance (piston to bore) - maximum of .005, unit may be rebuilt.

*Make a complete list of parts necessary to repair the brake system, so an accurate estimate may be written.

No. G-2 Road Test

Information Sheet #1

Road testing a vehicle is one of the best ways a mechanic can diagnose problems. Many systems are operating at once any time a car is being driven. Sorting out symptons which a given vehicle may have requires attentiveness while on the test drive. Ideally, the section of road you select is not too busy, and includes some curves, some straight sections, bumps, smooth pavement, and a hill or two.

Experience is the best teacher of the diagnostic skills involved in a road test, but a list of performance items which specifically apply to brakes is presented below. These apply either before or after doing repair work.

1. Pedal is firm - reasonably high - stops well.
2. Brakes do not pull to one side.
3. Brakes do not grab.
4. No noises in wheel area - foot on or off pedal.
5. Vehicle rolls free - no sign of brakes dragging.
6. Parking brake holds firm under strain.
7. Parking brake will release completely.
8. No pulsation or vibration when braking.

Brakes - Troubleshooting

No. G-3 Drum Systems

A. CONDITION: LOW PEDAL
(Lack of reserve; pedal height increased by "pumping"; pedal goes to floor)

Possible Cause	Corrective Procedure
1. Low fluid level permits air to enter the system.	Check system for leaks, repair, then refill master cylinder.
2. Leak in the hydraulic system.	Check the master cylinder, wheel cylinders, tubes, and hoses for leakage. Repair or replace faulty parts. Bleed system.
3. Poor quality brake fluid (low boiling point).	Drain the hydraulic system and fill with the approved brake fluid.
4. Improperly adjusted manual cylinder push rod.	If the car has an adjustable push rod, adjust it.
5. Improperly adjusted power brake hydraulic push rod.	Adjust the push rod.
6. Excessive clearance between drums and linings.	Adjust the brakes.

	Possible Cause	Corrective Procedure
7.	Automatic adjusters not working.	Make several forward and reverse stops; if pedal doesn't come up, repair the automatic adjusters. On the star-wheel type, check the pawl advancement.
8.	Brakes out of adjustment.	Adjust the brakes.
9.	Manual adjusters don't work.	Repair or replace manual adjusters.
10.	Bent or distorted brake shoes.	Replace the shoes and linings in axle sets.
11.	Residual pressure check valves don't hold pressure in lines.	Repair or replace the master cylinder.

B. CONDITION: PEDAL DROPS OR "FADES"
(Pedal travels (falls away) as brakes are held applied; "fade" is a temporary reduction of brake effectiveness.

1.	Plugged master cylinder compensating port(s), and or swollen master cylinder cups.	Rebuild or replace the master cylinder. Flush the hydraulic system and fill with approved brake fluid.
2.	Fluid seepage at hose joints and line connections.	Replace faulty parts.
3.	Fluid seepage at (or sticking) wheel cylinder piston cups.	Rebuild or replace wheel cylinder.
4.	Weak or broken shoe return springs.	Replace shoe return springs.
5.	Excessive drum expansion.	Check for re-bored thin drum, cracked drum, overheated conditions. Correct accordingly.

Possible Cause	Corrective Procedure
C. CONDITION: PEDAL PULSATION (Pedal chatter, fight, or vibration while braking).	
1. Worn or damaged front wheel bearings.	Replace bearings.
2. Out-of-round drums.	Recondition or replace the drums in axle sets.
3. Bent rear axle.	Replace the axle.
4. Excessive drum runout due to faulty installation of new drums.	Remove and properly install the drums.
D. CONDITION: SPONGY OR SPRINGY PEDAL (Pedal has a soft, spongy, or springy feel when depressed).	
1. Air in the brake system.	Refill and bleed. Check for possible fluid leaks at: . . Master cylinder secondary cup. . . Wheel cylinders or disc calipers. . . Hose and line connections . . Power brake vacuum line. Disconnect the vacuum line and check for pressure of fluid.
2. Fluid boil, vaporized by over-heating.	Check by opening the bleeder screw. CAUTION: Cooling will restore braking, but condition will return when brakes are heated. Drain and replace the fluid. Check for cause of boiling: . . Fluid-contaminated or wrong type for the system. . . Over-heated brakes-thin drums or rotors, spotty lining contacts, severe overloading of the vehicle. Correct accordingly.
3. Weak hoses expanding (ballooning) under pressure.	Replace the weak and faulty hoses.

4.	Loss of system residual pressure may permit air to seep into wheel cylinders.	Repair the valve leak or replace the residual pressure check valve.
5.	Improper use of parking brake (after the pedal is released) causes a pressure loss.	Check and correct the parking brake.
6.	Shoes bent, distorted, not centered in the drum.	Replace shoes and linings in axle sets. Adjust anchor pins (if provided). Check lining seating and drum eccentricity.
7.	Brake drum too thin.	Replace drum.

E. CONDITION: BRAKES DRAG, LOCK, OR OVERHEAT
(Either individual or all wheels drag or lock; severe reaction to pedal pressure)

1.	Rough or corroded master cylinder bore. Master cylinder by-pass port blocked by dirt or swollen primary cup.	Rebuild or replace the master cylinder.
2.	Binding brake pedal linkage; bind prevents the return of pedal against its stop.	Free up and lubricate.
3.	Weak pedal return spring (if used).	Replace the spring.
4.	Valve leaks, weak reaction springs, or bind in the power mechanism.	Repair or replace the power section of the power brake.
5.	Loose or worn front wheel bearings.	Adjust to specifications or replace.
6.	Defective brake hose or hydraulic tubing, preventing the return of brake fluid.	Replace the faulty tubes or hoses, as necessary.

	Possible Cause	Corrective Procedure
7.	Soft or swollen rubber parts caused by contaminated or incorrect brake fluid.	Replace all rubber parts, flush the hydraulic system, and fill with approved brake fluid.
8.	Incorrect, bent, or distorted shoes.	Replace shoes and linings in axle sets.
9.	Incorrect linings, or linings loose on shoes, or grease or brake fluid on linings.	Replace with correct shoes and linings. Repair grease seal or wheel cylinder.
10.	Weak or broken shoe return springs.	Replace the shoe return springs.
11.	Improper brake shoe adjustment.	Adjust shoes, and repair the automatic adjuster, if necessary.
12.	Shoes not centered in drums.	Adjust anchor pins (if provided).
13.	Loose, distorted or worn backing plate.	Tighten, recondition, or replace backing plate.
14.	Scored, hard spotted, or out of round drums.	Refinish or replace the drums in axle sets.
15.	Frozen parking brake cables.	Free up, and lubricate cables, or replace.
16.	Piston stuck in wheel cylinder.	Rebuild or replace wheel cylinder.

F. CONDITION: EXCESSIVE STOPPING DISTANCE AND/OR PEDAL EFFORT
(Hard Pedal; excessive pedal pressure is required to stop the car)

1.	After extended use, linings worn out or, poor quality brake linings.	Replace with approved shoes and linings in axle sets.
2.	"Faded" over-heated condition, glazed linings, "blued" or heat-checked drums.	Replace shoes and linings in axle sets.

Possible Cause	Corrective Procedure
3. Excessive lining clearance.	Check and correct pawl advancement on the automatic adjusters-star-wheel type. Adjust the manual adjusters.
4. Grease - or brake fluid - soaked linings.	Repair grease seal or wheel cylinder, as necessary, and replace shoes and linings in axle sets.
5. Low engine vacuum supply to power brake booster or defective power brake vacuum check valve.	Tune or repair the engine to obtain correct vacuum, or replace the check valve.
6. Faulty power brake booster.	Replace the power booster.
7. Loose or leaking vacuum hose to power brake booster.	Tighten clamps, or replace hose, as required.
8. Wheel cylinder or master cylinder piston stuck.	Rebuild or replace appropriate cylinder.
9. Brake Drum bell-mouthed or barrel shaped.	Refinish drum to proper limits, or replace it (if beyond refinishing limits).

G. CONDITION: SEVERE STOPS, DIVE

(Brakes sensitive to light pedal effort, excessive wheel skid).

1. Unbalanced "pull", any condition causing a brake to "grab".	Refer to the next condition, "car pulls to one side".
2. Abnormal front end "dive" . . Front suspension wear or alignment causing abnormal deflection, worn shocks, etc.	Front end wheel alignment needed. Repair or replace the affected parts.
. . Temporary "morning sickness" due to moisture and rust accumulation on cooled friction surfaces.	No cause for worry, if the conditions are temporary. If the condition persists, repair the affected parts.

Possible Cause	Corrective Procedure
H. CONDITION: CAR PULLS TO ONE SIDE	
1. Faulty suspension parts.	Repair suspension system.
2. Brake fluid, oil, grease, water, mud, dirt on linings.	Repair grease seal or wheel cylinder, as necessary, clean the affected parts, replace shoes and linings in axle sets.
3. Incorrect linings on shoes.	Replace with correct shoes and linings.
4. Distorted or incorrect shoes.	Replace with correct shoes and linings.
5. Shoes not centered in drums.	Adjust anchor pins (if provided).
6. Loose or distorted brake backing plate.	Tighten or replace the plate.
7. Weak shoe return springs or hold-downs.	Replace with new parts.
8. Drum bell-mouthed, barrel shaped, threaded, cracked or high hard spots on drum surface.	Recondition or replace drum.
9. Sticking wheel cylinder piston.	Repair or replace wheel cylinder.
10. Abnormal deflection, wear and improper alignment including caster, camber, weak or broken springs, broken spring center bolt, loose U-bolts, loose steering gear or tie rods, worn shock absorbers, etc.	Check and correct front end alignment. Repair or replace faulty parts.
11. Tire improperly inflated.	Inflate to correct pressure.

Possible Cause	Corrective Procedure
12. Faulty brake hose or obstruction in brake line.	Replace hose or line.
13. Charred or badly worn brake linings.	Replace linings and other worn parts.

I. CONDITION: BRAKE NOISES
(Squealing, clicking, scraping sounds or chatter upon brake application).

"Squeal"

Possible Cause	Corrective Procedure
1. With new linings: Improper arc grind or eccentric drum causes the lining to "pinch" against the drum.	Reface or grind the drums.
2. Dust or other particles imbedded in the lining.	Remove foreign matter. Replace the lining if necessary.
3. Loose lining rivets.	Reset the rivets or reline the shoes if the rivet holes in the linings are elongated.
4. Loose backing plate, anchor drum or wheel cylinder.	Tighten all loose parts and replace them if necessary.
5. Shoes scrape on support pads.	Clean and lubricate.
6. Weak or broken shoe hold-down springs.	Replace springs.
7. Support plate bent, shoes twisted.	Replace the plate and/or shoes.
8. Drums out-of-round or out-of-square.	Recondition or replace the drum.
9. Drum silencer (screen door) spring missing or weak.	Replace the spring.

Possible Cause	Corrective Procedure
"Grind"	
1. Lining worn. Rivets or shoe table rub on drum.	Replace shoes and linings.
2. Foreign material imbedded in lining.	Replace shoes and linings.
3. Rough drum surface.	Recondition or replace the drum.
"Chatter"	
1. Lining clearance too tight or too loose.	Adjust the linings to proper clearance.
2. Loose backing plate.	Tighten or replace the plate.
3. Grease, fluid or dust on lining surface.	Clean or replace the linings.
4. Twisted brake shoe.	Replace the shoes.
5. Drum out-of-round, bell-mouthed or barrel-shaped, cracked.	Recondition or replace the drum.
6. Weak or broken return spring.	Replace the springs.
7. Star wheel adjuster threads dry.	Lubricate the threads.
8. Loose wheel bearing.	Readjust wheel bearing.
"Click" Shoes lift off the support pads and snap-back:	
1. Threaded drum surface.	Replace the drum, or recondition.
2. Weak hold-downs.	Replace the hold-downs.
3. Grooves in brake shoe support pads.	Stone smooth and lubricate.

Possible Cause	Corrective Procedure
"Thumps"	
1. Excessive lining clearance. Applying, linings thump drums; releasing, shoes thump anchors.	Adjust the brakes to proper clearance.
"Groan"	
1. Unlubricated metal contacts.	Lubricate metal-to-metal contacts.
"Snapping"	
1. Dry metal to metal contacts.	Lubricate
2. Grooved shoe support pads.	Stone smooth.
3. Loose backing plate or loose drum.	Tighten or replace the affected parts.
4. Loose or worn front end components.	Tighten or replace the components.

Brakes - Troubleshooting

No. G-4 Disc Systems

Information Sheet # 1

Possible Cause	Corrective Procedure
A. CONDITION: DEPRESSING BRAKE PEDAL PRODUCES NO BRAKING EFFECT	
1. Reservoir fluid level low.	Check for cause of fluid leak, repair as required, refill the reservoir.
2. Air in the hydraulic system.	Check for cause, bleed system.
3. Bleeder screw open.	Close the bleeder screw and bleed the system.
4. Improperly positioned pads (while servicing the calipers, pistons may have been pushed back in cylinder bores).	Reposition pads.(Depress the pedal a second time).
5. Maladjusted rear brakes.	Adjust properly.
6. Leak in rear brake cylinder.	Hone the cylinder bore. Replace with new piston seals or replace caliper.
7. Piston seal damaged in one or more of the cylinders.	Disassemble the caliper and replace the piston seals.
8. Leak past piston cups in master cylinder.	Recondition or replace the master cylinder.
B. CONDITION: EXCESSIVE PEDAL EFFORT	
1. Pads worn below minimum thickness.	Install new pads.
2. Master cylinder or power brake malfunction.	Check and correct the affected parts.
3. "Faded" overheated condition, glazed pads, "blued" or heat-checked rotors.	Remachine the rotor.
4. Grease, oil, brake fluid on linings.	Install new pads.
5. Seized or frozen pistons.	Disassemble caliper and free up pistons.

Possible Cause	Corrective Procedure
C. CONDITION: EXCESSIVE PEDAL TRAVEL	
1. Air in the system	Bleed the system, replenish the fluid.
2. Insufficient or improper brake fluid (boil).	Drain, flush, and refill with correct fluid.
3. Master cylinder or power brake not functioning properly.	Check and repair the affected parts.
4. Excessive disc runout	Check with dial indicator, install new disc if runout exceeds maximum specified.
5. Excessively tapered or warped pads.	Install new pads.
6. Damaged caliper piston seal.	Install new piston seal.
7. Rear brakes out of adjustment.	Check and adjust as necessary.
8. Wheel bearings loosely adjusted.	Readjust to specified torque.
D. CONDITION: PEDAL PULSATION (Brake roughness or chatter)	
1. Excessive lateral runout of brake disc.	Check with dial indicator. Install new disc if runout exceeds the maximum specified.
2. Excessive out-of-parallelism of brake disc.	Check the parallelism (disc thickness variation) with micrometer and remachine the disc or install a new one, if the parallelism exceeds the maximum allowed.
3. Steering or suspension deflections.	Front end alignment.
4. Excessive front bearing clearance.	Readjust the bearings to specified torque.

Possible Cause	Corrective Procedure
E. CONDITION: CAR PULLS TO ONE SIDE	
1. Incorrect tire pressure.	Inflate (or deflate) tires to the recommended pressure.
2. Brake fluid, oil, grease, water, mud, or dirt on front or rear linings.	Install new pads.
3. Brakes grab; power brake malfunction.	Check and correct power unit.
4. Seized or frozen pistons.	Disassemble caliper and repair.
5. On rear brakes-maladjustment sticking pistons or broken spring.	Adjust the rear brakes, free up the pistons, install new spring.
6. Unmatched lining.	Install matched sets of pads.
7. Distorted disc brake shoes.	Install new brake pads.
8. Restricted hose or line.	Examine the hoses and lines, and replace as necessary.
9. Front end out of alignment.	Make proper wheel alignment.
F. CONDITION: LEAKY WHEEL CYLINDER	
1. Cylinder bore surface scored or corroded.	Disassemble caliper, hone cylinder bore, install new seal.
2. Caliper piston seal damaged or worn.	Disassemble caliper and install new seal.

Possible Cause	Corrective Procedure
G. CONDITION: FRONT BRAKES HEAT UP DURING DRIVING AND FAIL TO RELEASE	
1. Power brake malfunction.	Check and repair the power brake unit.
2. Residual check valve in the master cylinder front brake outlet.	Remove that valve from the master cylinder at front brake line outlet.
3. Sticking pedal linkage.	Free up and lubricate as necessary.
4. Frozen or seized pistons.	Disassemble the caliper and free up the pistons.
5. The driver in the habit of riding the brake pedal.	Instruct the driver to give up that habit.
H. CONDITION: BRAKE NOISES (Chatter, scraping, groan, rattle, etc.).	
"Chatter"	
1. Excessive lateral runout of rotor.	Check the runout with a dial indicator. Install new disc if the runout exceeds the maximum specified.
2. Rotor parallelism (lack of).	Check the parallelism with a micrometer. Remachine the disc, or install a new one, as required.
3. Loose wheel bearing.	Readjust the bearings to specified torque.
"Scraping"	
1. Rust or mud build-up on edges of rotor and on caliper housing.	Clean or replace, as necessary.
2. Worn pad, metal tabs or backing exposed to rotor.	Replace the pad. Repair or replace faulty parts.

Possible Cause	Corrective Procedure
3. Faulty caliper alignment permitting rotor to scrape on housing.	Adjust the caliper alignment properly.
4. Loose wheel bearing.	Readjust wheel bearings to correct specifications.
"Groan" or "Creep-grean"	
1. Slowly releasing the brakes.	Slightly increase or decrease the pedal effort to eliminate the noise.
"Rattle"	
(At low speeds on rough roads, front wheels only, brakes unapplied)	
1. Excessive clearance between shoe and caliper.	Install new pads.
2. Shoe anti-rattle spring missing or not properly positioned (Kelsey-Hayes or Budd types only).	Install new anti-rattle spring or position properly.

Brakes - Troubleshooting

No. G-5 Power Boosters

Information Sheet # 1

Possible Cause	Corrective Procedure
A. CONDITION: HARD PEDAL	
1. Faulty vacuum check valve.	Do not repair or oil the valve, replace it.
2. Engine intake manifold doesn't have sufficient (17"-20"/432-508 mm) vacuum.	Tune the engine, repair and adjust to obtain proper vacuum.
3. On Vacdraulic power units, electric pump inoperative.	Check wiring or replace with a new pump.
4. Plugged breather in power unit.	Clean or replace.
5. Vacuum hoses and line fittings plugged.	Clean the passages, or replace the faulty parts.
6. External vacuum leaks in reserve tank and loose vacuum connections.	Replace with new tank, tighten all vacuum connections.
7. Wrong type of lining.	Reline with new pads.
8. Restricted power brake air filter.	Wash filter in non-oil base cleaning fluid. Allow to dry before replacing, or install a new filter.
9. Brake fluid, oil, grease, or foreign matter on lining surface.	Correct the leaks. Reline the brakes with new shoe and lining sets.
10. Rusted or dry vacuum piston.	Lubricate vacuum piston, or replace the power brake unit.
11. Frozen brake pedal linkage.	Free up, lubricate, and replace the parts as necessary.
12. Internal vacuum leaks, or broken counter reaction spring (only on Vacdraulic type), or blocked air passage in the guide sleeve, or jammed power cylinder air valve in the power brake unit.	Replace the power brake unit.

	Possible Cause	Corrective Procedures
13.	Collapsed vacuum hose or dented tubing from the intake manifold to the power brake unit.	Replace with new hose or tubing.
14.	Only on Bellows type power units--the valve operating rod assembly bent or binding, Bellows leaking, or a defective vacuum valve.	Replace the power brake unit.
B.	CONDITION: PEDAL GOES TO FLOOR	
1.	Worn out brakes.	Reline with new pads.
2.	Air in the system.	Bleed the hydraulic system.
3.	Low fluid level, or external hydraulic fluid leaks.	Check for the leaks, and repair as necessary; replenish the fluid level.
4.	Faulty residual check valve primary cup, or contamination or rust.	Replace defective parts. Flush the system. Replace the power brake unit, if defective.
C.	CONDITION: PEDAL FAILS (OR SLOW) TO RELEASE	
1.	Pedal linkage frozen.	Free up, lubricate, replace necessary parts.
2.	Plugged breather in power brake unit.	Clean or replace.
3.	Plugged compensator port in the power brake unit.	Adjust the pedal linkage, flush the system, or replace the power brake unit.
4.	Piston stroke interference, or faulty residual check valve, or broken piston return spring, or sticky slide valve (do not oil) in the power brake unit.	Replace the power brake unit.

5.	Excessive hydraulic seal friction in the wheel cylinders and the power brake unit.	Replace the wheel cylinders or the power brake unit.

D. CONDITION: SENSITIVE BRAKES

1.	Brake fluid, oil, or grease on the lining surface.	Correct the leaks, install new pads.
2.	Lining surface burnt(overheated).	Replace the lining.
3.	Improper adjustment of the stop light switch.	Adjust or replace the switch.
4.	Binding pedal linkage.	Check for freeness, relieve, and lubricate.
5.	Reaction diaphragm leakage, or sticky slide valve action, or closed or restricted atmospheric passage in the vacuum piston assembly, or binding rubber seals in the power brake unit.	Replace the power brake unit.

E. CONDITION: BRAKE PEDAL CHATTER

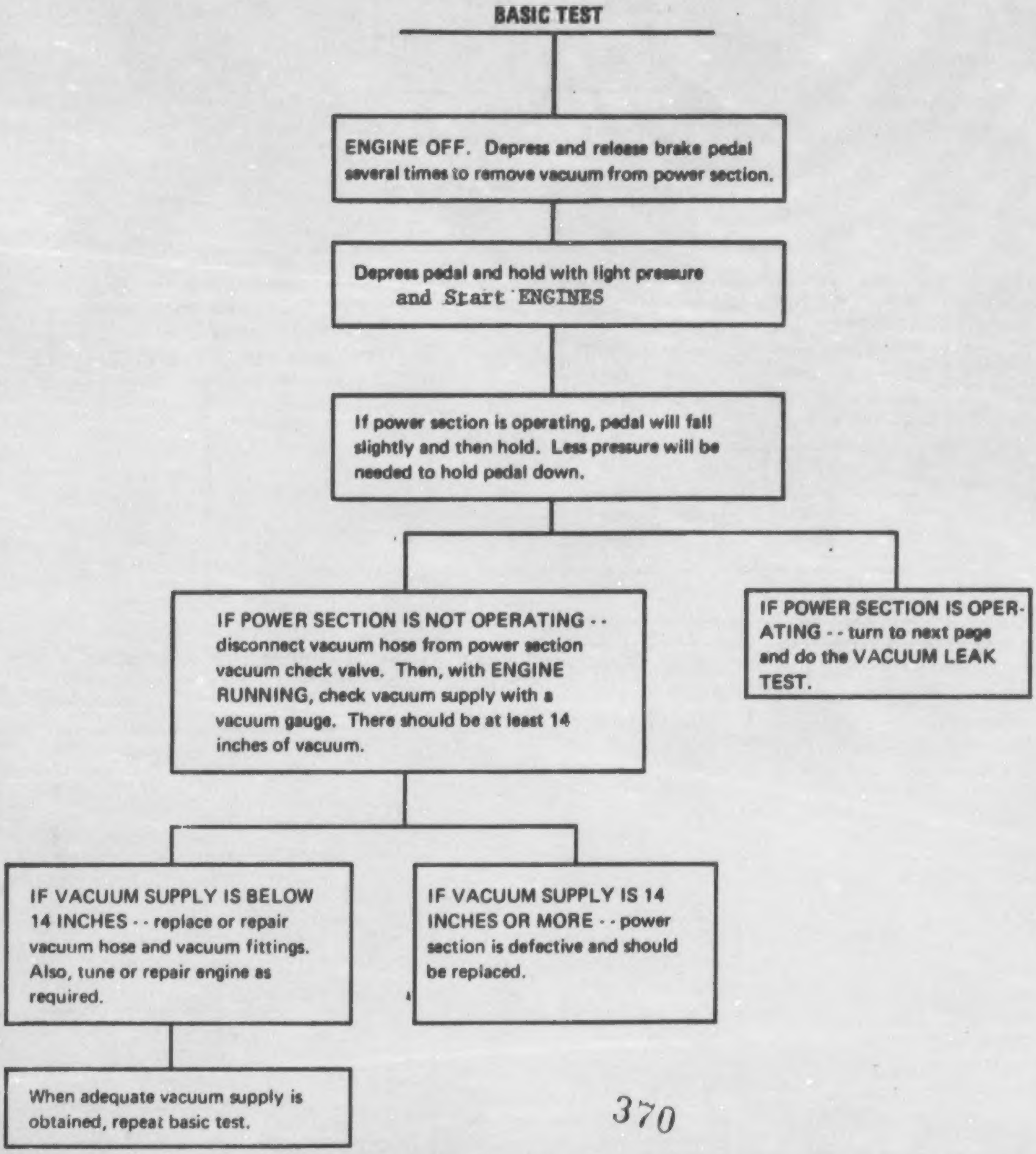
1.	Air in the system.	Bleed the system.
2.	Power brake trigger rubber collar damaged or missing.	Install a new rubber collar.
*3.	Power brake trigger bent or out of adjustment.	Replace the trigger, adjust the linkage.
*4.	Binding inside power brake unit.	Replace the power brake unit.
*5.	Improperly adjusted master cylinder push rod.	Adjust the push rod to proper clearance.

*(Only in Bellows type power units)

F. CONDITION: PEDAL VIBRATES AND POWER BRAKES CHATTER

1. Air in the system	Bleed the system.
2. Improperly adjusted brake pedal free play.	Readjust brake pedal free play.

Trouble-Shooting Power Brakes



BASIC TEST

ENGINE OFF. Depress and release brake pedal several times to remove vacuum from power section.

Depress pedal and hold with light pressure and Start ENGINES

If power section is operating, pedal will fall slightly and then hold. Less pressure will be needed to hold pedal down.

IF POWER SECTION IS NOT OPERATING - - disconnect vacuum hose from power section vacuum check valve. Then, with ENGINE RUNNING, check vacuum supply with a vacuum gauge. There should be at least 14 inches of vacuum.

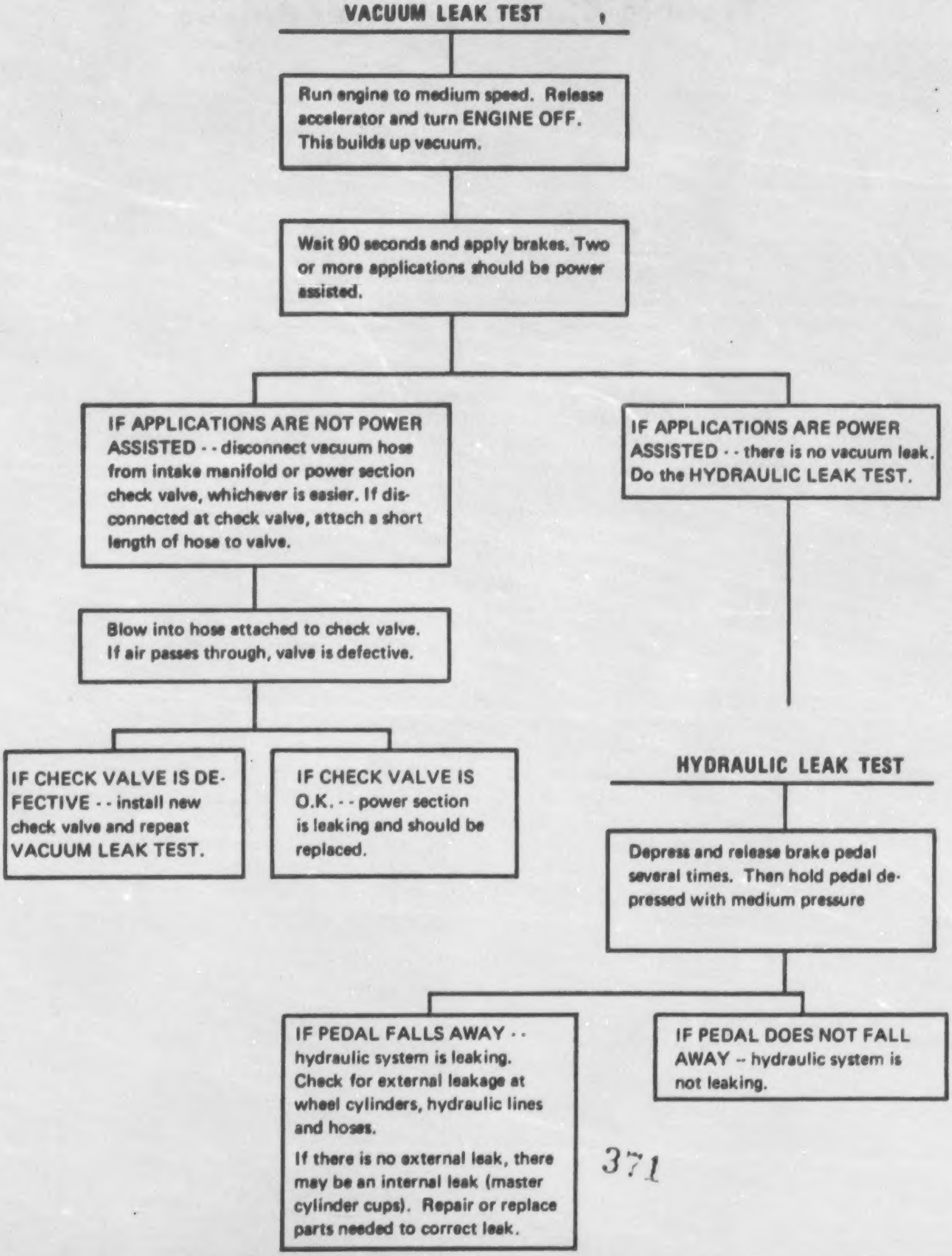
IF POWER SECTION IS OPERATING - - turn to next page and do the VACUUM LEAK TEST.

IF VACUUM SUPPLY IS BELOW 14 INCHES - - replace or repair vacuum hose and vacuum fittings. Also, tune or repair engine as required.

IF VACUUM SUPPLY IS 14 INCHES OR MORE - - power section is defective and should be replaced.

When adequate vacuum supply is obtained, repeat basic test.

Trouble-Shooting Power Brakes—CONT'D.



VACUUM LEAK TEST

Run engine to medium speed. Release accelerator and turn ENGINE OFF. This builds up vacuum.

Wait 90 seconds and apply brakes. Two or more applications should be power assisted.

IF APPLICATIONS ARE NOT POWER ASSISTED - - disconnect vacuum hose from intake manifold or power section check valve, whichever is easier. If disconnected at check valve, attach a short length of hose to valve.

Blow into hose attached to check valve. If air passes through, valve is defective.

IF CHECK VALVE IS DEFECTIVE - - install new check valve and repeat VACUUM LEAK TEST.

IF CHECK VALVE IS O.K. - - power section is leaking and should be replaced.

IF APPLICATIONS ARE POWER ASSISTED - - there is no vacuum leak. Do the HYDRAULIC LEAK TEST.

HYDRAULIC LEAK TEST

Depress and release brake pedal several times. Then hold pedal depressed with medium pressure

IF PEDAL FALLS AWAY - - hydraulic system is leaking. Check for external leakage at wheel cylinders, hydraulic lines and hoses.

If there is no external leak, there may be an internal leak (master cylinder cups). Repair or replace parts needed to correct leak.

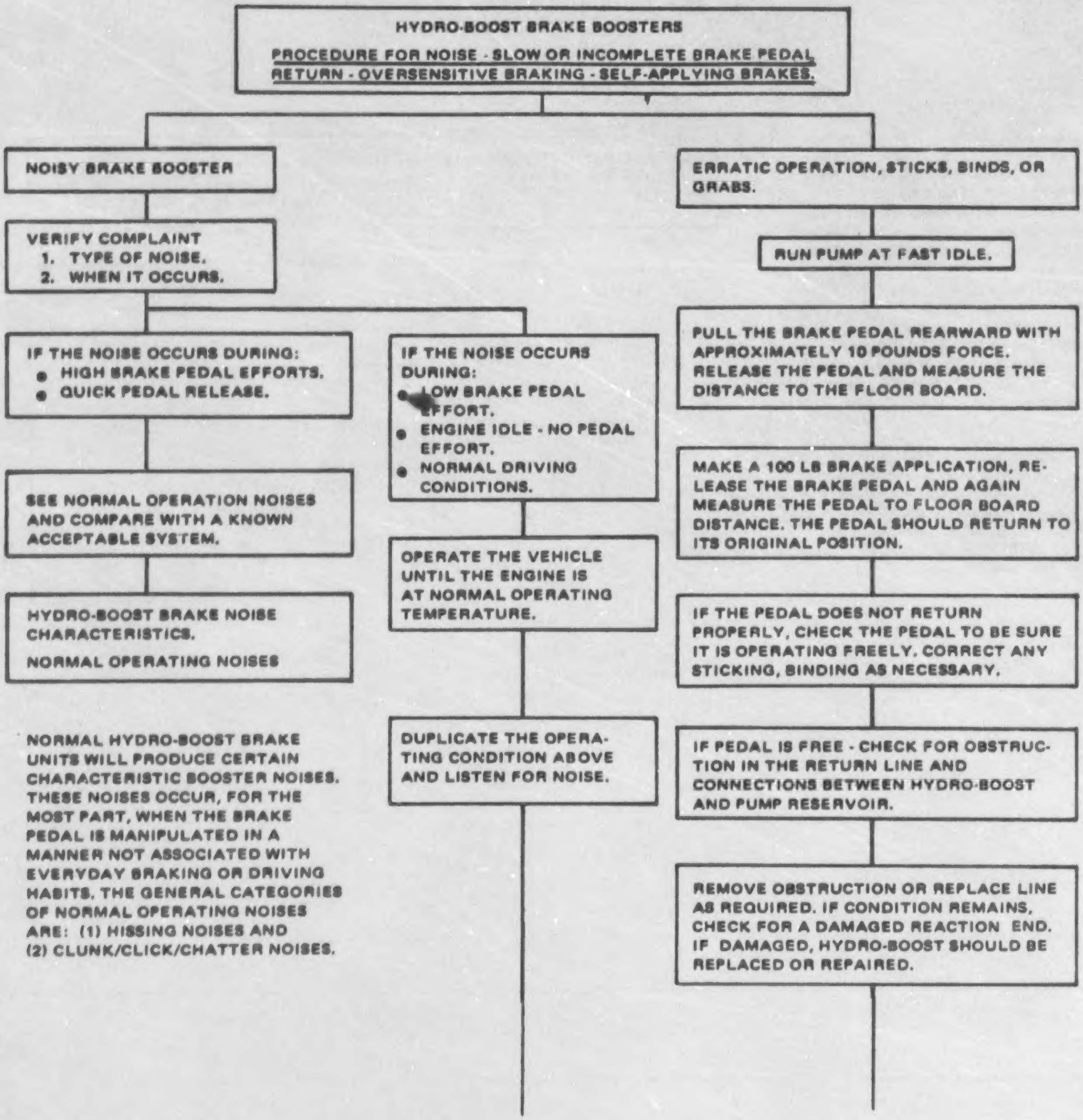
IF PEDAL DOES NOT FALL AWAY -- hydraulic system is not leaking.

Brakes - Troubleshooting

No. G-6 Hydro-Boost

Information Sheet # 1

HYDRO-BOOST CHECK-OUT PROCEDURE



HYDRO-BOOST BRAKE BOOSTERS

PROCEDURE FOR NOISE - SLOW OR INCOMPLETE BRAKE PEDAL RETURN - OVERSENSITIVE BRAKING - SELF-APPLYING BRAKES.

NOISY BRAKE BOOSTER

VERIFY COMPLAINT
1. TYPE OF NOISE.
2. WHEN IT OCCURS.

IF THE NOISE OCCURS DURING:
- HIGH BRAKE PEDAL EFFORTS.
- QUICK PEDAL RELEASE.

SEE NORMAL OPERATION NOISES AND COMPARE WITH A KNOWN ACCEPTABLE SYSTEM.

HYDRO-BOOST BRAKE NOISE CHARACTERISTICS.

NORMAL OPERATING NOISES

NORMAL HYDRO-BOOST BRAKE UNITS WILL PRODUCE CERTAIN CHARACTERISTIC BOOSTER NOISES. THESE NOISES OCCUR, FOR THE MOST PART, WHEN THE BRAKE PEDAL IS MANIPULATED IN A MANNER NOT ASSOCIATED WITH EVERYDAY BRAKING OR DRIVING HABITS. THE GENERAL CATEGORIES OF NORMAL OPERATING NOISES ARE: (1) HISSING NOISES AND (2) CLUNK/CLICK/CHATTER NOISES.

IF THE NOISE OCCURS DURING:
- LOW BRAKE PEDAL EFFORT.
- ENGINE IDLE - NO PEDAL EFFORT.
- NORMAL DRIVING CONDITIONS.

OPERATE THE VEHICLE UNTIL THE ENGINE IS AT NORMAL OPERATING TEMPERATURE.

DUPLICATE THE OPERATING CONDITION ABOVE AND LISTEN FOR NOISE.

ERRATIC OPERATION, STICKS, BINDS, OR GRABS.

RUN PUMP AT FAST IDLE.

PULL THE BRAKE PEDAL REARWARD WITH APPROXIMATELY 10 POUNDS FORCE. RELEASE THE PEDAL AND MEASURE THE DISTANCE TO THE FLOOR BOARD.

MAKE A 100 LB BRAKE APPLICATION, RELEASE THE BRAKE PEDAL AND AGAIN MEASURE THE PEDAL TO FLOOR BOARD DISTANCE. THE PEDAL SHOULD RETURN TO ITS ORIGINAL POSITION.

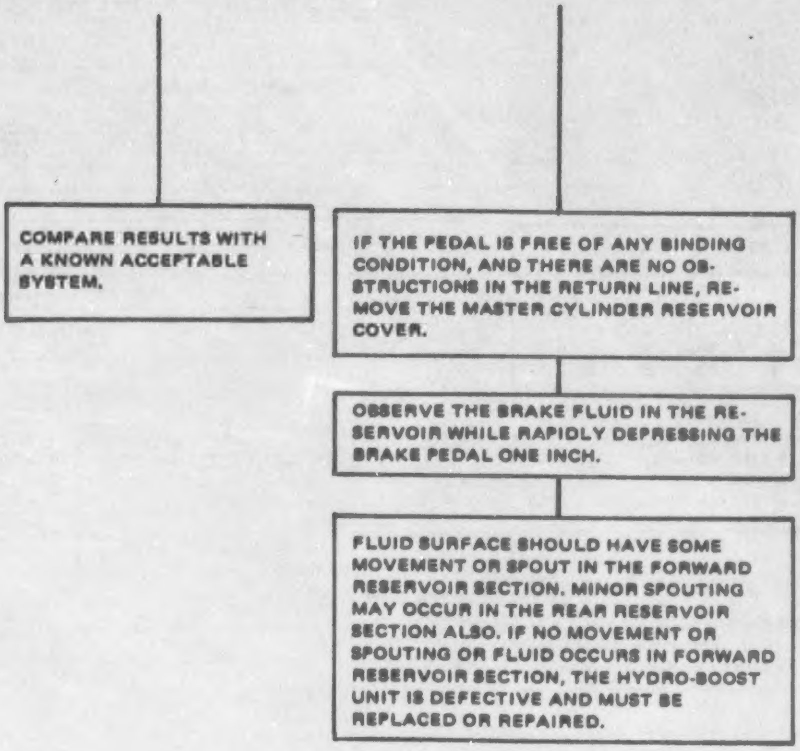
IF THE PEDAL DOES NOT RETURN PROPERLY, CHECK THE PEDAL TO BE SURE IT IS OPERATING FREELY. CORRECT ANY STICKING, BINDING AS NECESSARY.

IF PEDAL IS FREE - CHECK FOR OBSTRUCTION IN THE RETURN LINE AND CONNECTIONS BETWEEN HYDRO-BOOST AND PUMP RESERVOIR.

REMOVE OBSTRUCTION OR REPLACE LINE AS REQUIRED. IF CONDITION REMAINS, CHECK FOR A DAMAGED REACTION END. IF DAMAGED, HYDRO-BOOST SHOULD BE REPLACED OR REPAIRED.

THE HYDRO-BOOST WILL EMIT NORMAL HISSING NOISES WHEN ABOVE NORMAL BRAKE PEDAL EFFORTS ARE APPLIED (40 LBS. PEDAL EFFORT AND UP). THE HISS SOUNDS ARE PARTICULARLY NOTICEABLE WITH THE VEHICLE MOTIONLESS AND WILL INCREASE IN INTENSITY AS PEDAL PRESSURE INCREASES ABOVE 40 LBS. AND SYSTEM OPERATING TEMPERATURE INCREASES. LOUD HISSING SOUNDS AT OR BELOW NORMAL (20-25 LBS.) PEDAL EFFORT WARRANTS INVESTIGATION.

CLUNK, CHATTER, OR CLICKING NOISES WILL BE HEARD WHEN THE BRAKE PEDAL IS QUICKLY RELEASED FROM HARD (50-100 LBS.) PEDAL EFFORTS.



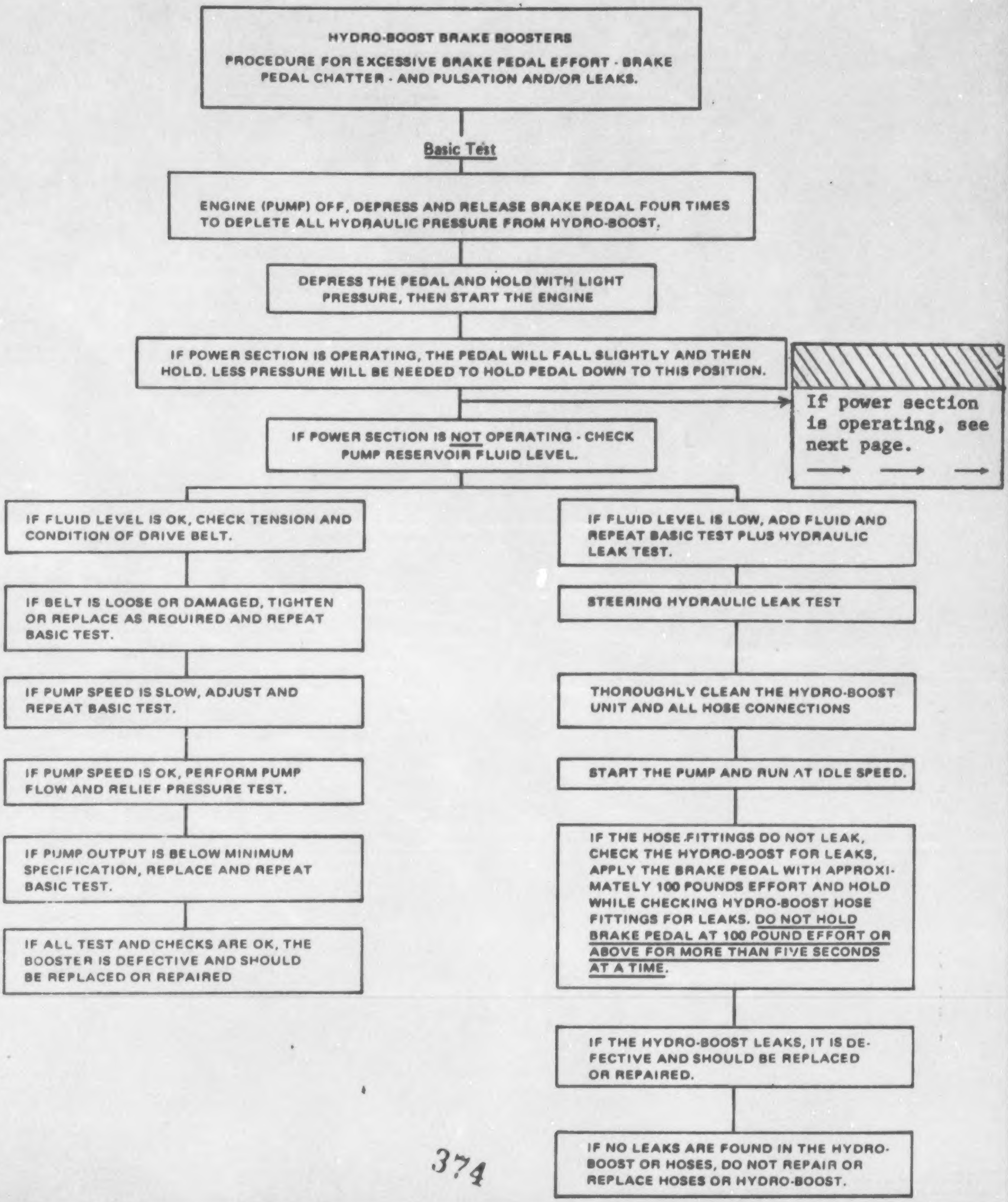
COMPARE RESULTS WITH A KNOWN ACCEPTABLE SYSTEM.

IF THE PEDAL IS FREE OF ANY BINDING CONDITION, AND THERE ARE NO OBSTRUCTIONS IN THE RETURN LINE, REMOVE THE MASTER CYLINDER RESERVOIR COVER.

OBSERVE THE BRAKE FLUID IN THE RESERVOIR WHILE RAPIDLY DEPRESSING THE BRAKE PEDAL ONE INCH.

FLUID SURFACE SHOULD HAVE SOME MOVEMENT OR SPOUT IN THE FORWARD RESERVOIR SECTION. MINOR SPOUTING MAY OCCUR IN THE REAR RESERVOIR SECTION ALSO. IF NO MOVEMENT OR SPOUTING OR FLUID OCCURS IN FORWARD RESERVOIR SECTION, THE HYDRO-BOOST UNIT IS DEFECTIVE AND MUST BE REPLACED OR REPAIRED.

Information Sheet # 2



HYDRO-BOOST BRAKE BOOSTERS

PROCEDURE FOR EXCESSIVE BRAKE PEDAL EFFORT - BRAKE PEDAL CHATTER - AND PULSATION AND/OR LEAKS.

Basic Test

ENGINE (PUMP) OFF, DEPRESS AND RELEASE BRAKE PEDAL FOUR TIMES TO DEPLETE ALL HYDRAULIC PRESSURE FROM HYDRO-BOOST.

DEPRESS THE PEDAL AND HOLD WITH LIGHT PRESSURE, THEN START THE ENGINE

IF POWER SECTION IS OPERATING, THE PEDAL WILL FALL SLIGHTLY AND THEN HOLD. LESS PRESSURE WILL BE NEEDED TO HOLD PEDAL DOWN TO THIS POSITION.

If power section is operating, see next page.

IF POWER SECTION IS NOT OPERATING - CHECK PUMP RESERVOIR FLUID LEVEL.

IF FLUID LEVEL IS OK, CHECK TENSION AND CONDITION OF DRIVE BELT.

IF BELT IS LOOSE OR DAMAGED, TIGHTEN OR REPLACE AS REQUIRED AND REPEAT BASIC TEST.

IF PUMP SPEED IS SLOW, ADJUST AND REPEAT BASIC TEST.

IF PUMP SPEED IS OK, PERFORM PUMP FLOW AND RELIEF PRESSURE TEST.

IF PUMP OUTPUT IS BELOW MINIMUM SPECIFICATION, REPLACE AND REPEAT BASIC TEST.

IF ALL TEST AND CHECKS ARE OK, THE BOOSTER IS DEFECTIVE AND SHOULD BE REPLACED OR REPAIRED

IF FLUID LEVEL IS LOW, ADD FLUID AND REPEAT BASIC TEST PLUS HYDRAULIC LEAK TEST.

STEERING HYDRAULIC LEAK TEST

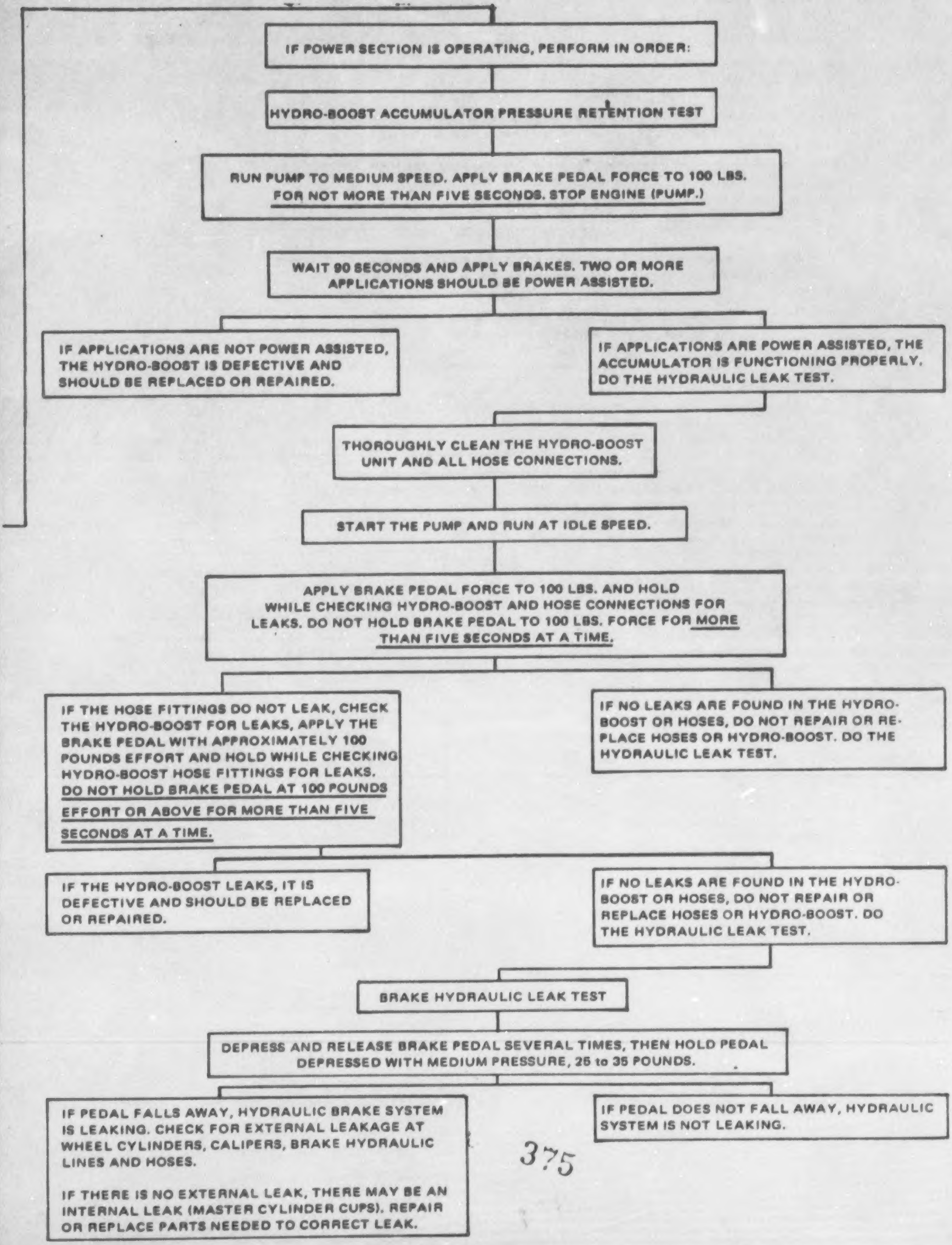
THOROUGHLY CLEAN THE HYDRO-BOOST UNIT AND ALL HOSE CONNECTIONS

START THE PUMP AND RUN AT IDLE SPEED.

IF THE HOSE FITTINGS DO NOT LEAK, CHECK THE HYDRO-BOOST FOR LEAKS, APPLY THE BRAKE PEDAL WITH APPROXIMATELY 100 POUNDS EFFORT AND HOLD WHILE CHECKING HYDRO-BOOST HOSE FITTINGS FOR LEAKS. DO NOT HOLD BRAKE PEDAL AT 100 POUND EFFORT OR ABOVE FOR MORE THAN FIVE SECONDS AT A TIME.

IF THE HYDRO-BOOST LEAKS, IT IS DEFECTIVE AND SHOULD BE REPLACED OR REPAIRED.

IF NO LEAKS ARE FOUND IN THE HYDRO-BOOST OR HOSES, DO NOT REPAIR OR REPLACE HOSES OR HYDRO-BOOST.



IF POWER SECTION IS OPERATING, PERFORM IN ORDER:

HYDRO-BOOST ACCUMULATOR PRESSURE RETENTION TEST

RUN PUMP TO MEDIUM SPEED. APPLY BRAKE PEDAL FORCE TO 100 LBS. FOR NOT MORE THAN FIVE SECONDS. STOP ENGINE (PUMP.)

WAIT 90 SECONDS AND APPLY BRAKES. TWO OR MORE APPLICATIONS SHOULD BE POWER ASSISTED.

IF APPLICATIONS ARE NOT POWER ASSISTED, THE HYDRO-BOOST IS DEFECTIVE AND SHOULD BE REPLACED OR REPAIRED.

IF APPLICATIONS ARE POWER ASSISTED, THE ACCUMULATOR IS FUNCTIONING PROPERLY. DO THE HYDRAULIC LEAK TEST.

THOROUGHLY CLEAN THE HYDRO-BOOST UNIT AND ALL HOSE CONNECTIONS.

START THE PUMP AND RUN AT IDLE SPEED.

APPLY BRAKE PEDAL FORCE TO 100 LBS. AND HOLD WHILE CHECKING HYDRO-BOOST AND HOSE CONNECTIONS FOR LEAKS. DO NOT HOLD BRAKE PEDAL TO 100 LBS. FORCE FOR MORE THAN FIVE SECONDS AT A TIME.

IF THE HOSE FITTINGS DO NOT LEAK, CHECK THE HYDRO-BOOST FOR LEAKS, APPLY THE BRAKE PEDAL WITH APPROXIMATELY 100 POUNDS EFFORT AND HOLD WHILE CHECKING HYDRO-BOOST HOSE FITTINGS FOR LEAKS. DO NOT HOLD BRAKE PEDAL AT 100 POUNDS EFFORT OR ABOVE FOR MORE THAN FIVE SECONDS AT A TIME.

IF NO LEAKS ARE FOUND IN THE HYDRO-BOOST OR HOSES, DO NOT REPAIR OR REPLACE HOSES OR HYDRO-BOOST. DO THE HYDRAULIC LEAK TEST.

IF THE HYDRO-BOOST LEAKS, IT IS DEFECTIVE AND SHOULD BE REPLACED OR REPAIRED.

IF NO LEAKS ARE FOUND IN THE HYDRO-BOOST OR HOSES, DO NOT REPAIR OR REPLACE HOSES OR HYDRO-BOOST. DO THE HYDRAULIC LEAK TEST.

BRAKE HYDRAULIC LEAK TEST

DEPRESS AND RELEASE BRAKE PEDAL SEVERAL TIMES, THEN HOLD PEDAL DEPRESSED WITH MEDIUM PRESSURE, 25 to 35 POUNDS.

IF PEDAL FALLS AWAY, HYDRAULIC BRAKE SYSTEM IS LEAKING. CHECK FOR EXTERNAL LEAKAGE AT WHEEL CYLINDERS, CALIPERS, BRAKE HYDRAULIC LINES AND HOSES.

IF THERE IS NO EXTERNAL LEAK, THERE MAY BE AN INTERNAL LEAK (MASTER CYLINDER CUPS). REPAIR OR REPLACE PARTS NEEDED TO CORRECT LEAK.

IF PEDAL DOES NOT FALL AWAY, HYDRAULIC SYSTEM IS NOT LEAKING.

No.

Test

Name_____________________________Date__________Grade________

Write the letter corresponding to the correct response in the blank to the left of each question.

_____ 1). A firm, steady pressure on the brake pedal results in the pedal slowly sinking to the floor. No external fluid leaks can be detected. What is the most likely cause?

A. Leaking secondary cup
B. Defective residual check valve
C. Plugged inlet port
D. Leaking primary cup

_____ 2). On a slick road condition, what prevents the front disc brakes from locking up at light pedal pressures before the drum brakes develop sufficient stopping force?

A. Proportioning valve
B. By-pass valve
C. Residual valve
D. Metering valve

_____ 3). The owner of an American passenger car complains of a pull to the right when he steps on the brakes.

Mechanic A says the trouble could be caused by the master cylinder (dual type).

Mechanic B says the trouble could be a faulty metering or proportioning valve. Who is right?

A. Mechanic A
B. Mechanic B
C. Either A or B
D. Neither A nor B

_____ 4). A plugged master cylinder filler cap vent can cause:

A. Brake fluid to be forced out through the secondary cup in the master cylinder
B. A spongy brake pedal
C. The brakes to drag
D. None of the above

_____ 5). Which of the following could cause brake "fade"?

A. Excessive drum expansion
B. Glazed linings
C. Faulty suspension system parts
D. Both A and B

_____ 6). A squeaking noise when the vehicle is moving and the pedal is not depressed in a disc brake system could be caused by which of the following:

A. Loose or missing anti-rattle spring
B. Inadequate lubrication on mounting hardware
C. Both A and B
D. Neither A nor B

_____ 7). On a vehicle with combination drum (rear) and disc (front) brakes, a pulsation is felt whenever the brake pedal is depressed. Which of the following could cause this condition?

A. Cracked drum
B. Out of true rotor
C. Wheel bearings out of adjustment
D. A and C only
E. All of the above

_____ 8). A spongy feeling pedal can be caused by:

A. Poor quality brake fluid that has exceeded boiling point
B. Weak brake hoses
C. Grease on brake linings
D. A and B only
E. All of the above

_____ 9). The brake pedal on a vehicle with a combination disc and drum brake system sinks almost to the floor as soon as pressure is applied, and will not pump up.

Mechanic A says the brakes need to be adjusted.
Mechanic B says there is probably air in the hydraulic system.
Who is right?

A. Mechanic A
B. Mechanic B
C. Both A and B
D. Neither A nor B

Brakes - Troubleshooting

No. G

Test
Page 3

Name____Date____________Grade______

_____10). A customer complains of a grinding noise whenever the brakes are applied. Which of the following could cause this problem?

A. Weak hold-down springs
B. Seized or frozen pistons
C. Worn linings
D. Grease or fluid on linings

_____11). Which of the following conditions could cause brakes to pull to one side?

A. Grease on one rear lining set
B. Frozen caliper piston on one side
C. Low tire pressure on one side
D. A and B only
E. All of the above

_____12). Mechanic A says overly sensitive brakes can be caused by brake fluid, oil or grease on lining surfaces. Mechanic B says it is more likely that the trigger in the power booster is bent. Who is right?

A. Mechanic A
B. Mechanic B
C. Both A and B
D. Neither A nor B

_____13). A vehicle with a hydro-boost brake booster has a pedal chatter when applying the brakes. The fluid level is o.k. Which of the following might cause this condition?

A. Loose belt
B. Low pump output
C. Faulty pressure sensor
D. Either A or B

____14). Which of the following could cause a need for excessive pedal pressure in order to perform normal braking?

A. Leaky rear wheel cylinder
B. Malfunctioning metering valve
C. Extremely glazed linings
D. Bent rear axle

____15). Which of the following conditions could cause all brakes to drag after being applied?

A. Rough or corroded master cylinder bore
B. Grease on rear brake linings
C. Leak in the hydraulic system
D. A or C above

This is to certify that

____

has completed a high school vocational course in

Auto Mechanics

Furthermore, this individual has reached performance levels for various skills within this vocation. These levels and the rating scale used are attached to this certificate.

Instructor ____________________ Date ________________________

TASK AND SKILL LIST

TASK AND SKILL LIST	R & R	TEST DIAGNOSE	SERVICE
I. ELECTRICAL SYSTEMS			
A. Battery			
B. Starter, cables, solenoid			
C. Alternator, regulator			
D. Tune-up: Points, plugs, cap, wires, distributor, coil			
E. Tune-up: Electronic module, distributor, cap, wires, coil			
F. Headlights, taillights, signal lights, switches			
Equipment			
Scope			
Distributor Tester			
V.A.T.			
Armature Growler			
Headlight Aimer			
Electronic Ignition Tester			
Magnetic Induction Timing			
II. ENGINE MACHINING AND REBUILDING			
A. Pre-teardown inspection: Compression, leakage, vacuum, smoke, infra-red			
B. Cam, timing chain, gears, oil pump, pushrods, rockers, and lifters			
C. Rebuild, measure, assemble and adjust: 1. Cylinder head assembly: Valve seats, faces, guides, seals, spring pressures, stem heights			
2. Cylinder block assembly: Main, rod and cam bearings			
D. Engine assembly: Cylinder heads, manifolds, gaskets			
E. Final adjustment and break-in			
Equipment			

	R & R	TEST DIAGNOSE	SERVICE
V. DRIVE TRAINS			
A. Clutch disc, pressure plate, pilot and release bearings, linkage			
B. Manual transmission: Linkage, external seals			
C. Automatic transmission: Bands, modulators, linkage			
D. U-joints, C-V joints, center bearing			
E. Differentials, axles, bearings, seals			
Equipment			
Hydraulic Press			
VI. BRAKES			
A. Drum/rotor			
B. Pads, shoes, adjusters, springs			
C. Parking brake cables and linkage			
D. Wheel cylinder, caliper, master cylinders, bleeding, lines and hoses			
Equipment			
Brake Lathe			
Drum Micrometer			
VII. SUSPENSION AND STEERING			
A. Sway bars, bushings, springs, ball joints, control arms, shocks			
B. Tie rods, idler arms, manual steering gear box			
C. Power steering pump and gear box			
D. Complete front end alignment			
Equipment			

Valve Grinder
Boring Bar
Seat Grinding Equipment
Valve Guide Knurling Equipment
Cylinder Leakage Tester

III. COOLING, HEATING AND AIR CONDITIONING

A. Cooling system: Thermostat, water pump, radiator and cap
B. Heater core, blower motor
C. A/C leak test, evacuate, charge

Equipment

Radiator Pressure Tester
A/C Manifold Gauge Set
A/C Leak Tester
A/C Charging Station

IV. FUEL AND EMISSION CONTROL SYSTEMS

A. Fuel pump, lines, tank and filters
B. Carburetor adjustments: Speed, mixture, chokes, linkages, anti-dieseling solenoid, heat riser
C. Carburetor overhaul
D. Carbon canister, heated air intake
E. P.C.V. valve, E.G.R. valve, air pump and catalytic converter
F. Fuel injection: Pump, injectors, regulator

Equipment

Infra-red Tester
Air/Fuel Ratio Tester
Fuel Pump Tester
Propane Enrichment

Front End Alignment Equipment

VIII. GENERAL SERVICE

A. Grease, oil and air filter
B. Tire, inner tube, valve stem
C. Bubble, spin balance
D. Muffler, tailpipe, exhaust pipe
E. Coolant flush and fill, belts, hoses
F. Safety inspection: Suspension, steering, lighting, warning and braking system
G. Clean windows, vacuum interior
H. Front wheel bearings and seals
I. Automatic transmission fluid and filter
J. Use of manuals
K. Parts and labor estimating

Equipment

Wheel Balancer
  1. Bubble
  2. Spin
Tire Changer
Flushing Equipment
Oxy-acetylene torch

IX. ADDITIONAL TASKS AND SKILLS

HOW SKILL IS MEASURED

Each skill on the task list is defined in terms of observable performance and is rated by the instructor. The rating is located to the right of the task for each area listed.

Can perform this task satisfactorily with little or no assistance.	3
Can perform this task satisfactorily but requires periodic supervision and/or assistance.	2
Can perform this task, but not without constant supervision and some assistance.	1
Task not observed at time of rating.	–

Adapted from the DACUM System developed by Robert E. Adams,
Dartmouth, Nova Scotia, Canada

TERMS

R & R includes removing and reinstalling a complete unit or specified component part of that unit.

Test & Diagnose includes inspection, measuring, and/or troubleshooting of component parts or complete systems.

Service includes disassembly, assembly, adjustments, machining, rebuilding, cleaning and replacement of subassembly component parts.

For verification of the high school rating, additional information, or additional copies of this rating chart, write to:

Release of official records, including attendance and grades, requires written authorization from the student involved.